THE Chemical Age

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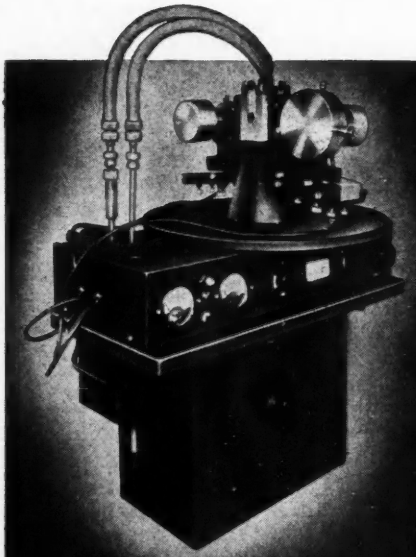

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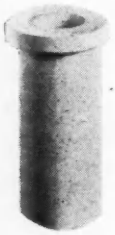

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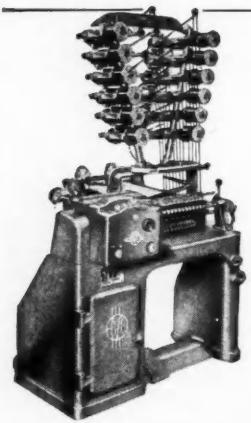

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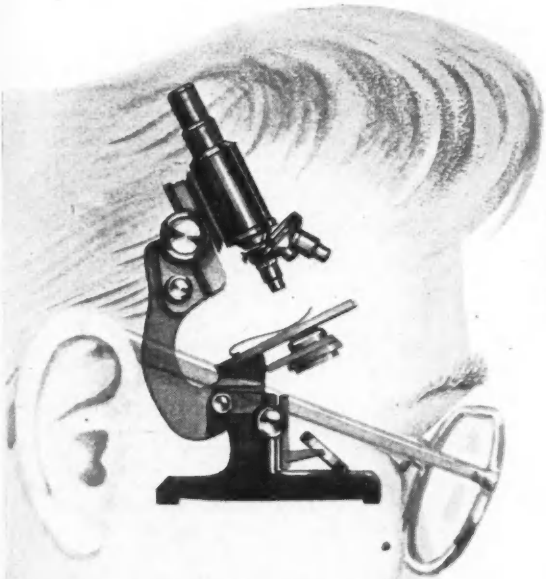

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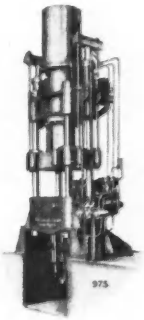

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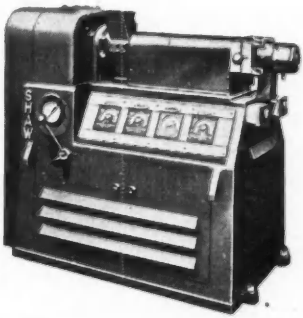

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Good Measure

MEASUREMENT is the very life-blood of modern science. We take for granted this essential metabolic fact though it needs but little delving into the history of science to reveal the predominance of theorising and the conspicuous absence of measurement that characterised even the greatest of phases in pre-nineteenth century science. It is notable, nevertheless, that the major advances by which modern science has evolved were mostly made by men who could not only produce plausible patterns of ideas but who could construct apparatus and subject their speculations to the test of numerical values.

A nation's scientific health rests very heavily upon the health of its apparatus and instrument industry. Only a few decades ago it might have been reasonable to say that advances in instrumentation affected research in the main but had small impact upon everyday routine science. Today, instruments of measurement are dominating industrial progress. Measurement is no longer a laboratory prerogative, a verdict upon performance belatedly emerging from a remote back-room; it has become a factory-floor operation with immediate effect upon the flowlines of quality and quantity. We need instruments that can measure an effect or factor with differing standards of accuracy, with speed and an acknowledged degree of inaccuracy or much more leisurely and with a high degree of accuracy.

The primary function of the apparatus and instrument industry is to supply the home market. Whatever emphasis may be generally laid upon the national need for exports, the importance of science and research to all industries is so great that currency considerations here must rank, or should be ranked, as a subsidiary influence. The expansion of this industry so that it can take its place among exporting industries is a secondary function. These somewhat obvious points need firm statement as there is a tendency today to judge all British manufacturing industries largely upon their performance as exporters. We need not go back very far into history to find a time when British needs for apparatus and instruments were heavily met by imports, particularly from Germany. The extent to which we are more self-reliant for these needs today offers perhaps the best judgment on the British industry's progress.

Paradoxically figures about the industry's output are scarce. Official statistics are unreliable sources, for cameras tend to be grouped with optical instruments and radio sets with electronic equipment; to break down trade volume totals so that purely scientific goods are separated from ordinary consumer goods is largely a matter of guesswork. A figure given in 1952 by Sir Ben Lockspeiser put the annual product value of the industry at £50,000,000. Of this amount at least £10,000,000 was derived from export sales. A 4:1 home/export trade ratio is probably a rough but reasonable estimate of the post-war balance. There are indications, however, that export sales are now meeting more intensive competition from Germany, and that Japan is becoming threateningly efficient in the field of electronic instruments. The pursuit of export business is not easily conducted. Most of the British industry is composed of relatively small but specialised firms, each of whom would find it uneconomic to maintain foreign offices or permanent overseas representatives. Some easement of this difficulty has been achieved by the formation of Sciex Ltd., an export organisation sponsored by a number of British instrument companies, which now has offices in South Africa and Toronto. Obtaining foreign business for apparatus and instruments is not wholly a matter

of price competition, increasingly important though this factor is; there is also the factor of after-sales service, especially for the more modern types of equipment. In all countries the home industry, and in Canada the adjacent US industry, has a powerful and natural advantage in this phase of salesmanship.

The industry, through one of its leading associations, SIMA or the Scientific Instrument Manufacturers' Association, has actively participated in a number of post-war international exhibitions. In 1953 at the Zagreb Fair all the instruments shown at a composite SIMA stand were sold and there has since been continued and promising trade development with Yugoslavia; there will be a similar stand at the first International Instruments Congress at Philadelphia in September. Since the war exhibitions at Stockholm, Copenhagen and Toronto have also been supported.

Almost every department of scientific measurement is today being invaded by electronics; here, indeed, there may be some danger of fashionable exaggeration, with complex electronic equipment unnecessarily displacing simpler and adequate methods of measurement. Even optical instruments are undergoing electronic revolution. This is a world development, but it would seem to be one in which the British industry can play a significant part. About one-third of the firms who are members of SIMA are manufacturers of electronic instruments. We are by no means backward in this branch of scientific development. Another new and important field has sprung up rapidly from the use of radio-isotopes in research and in specialised industrial control work. Labelled isotopes cannot tell their delicate and unique tales without instruments to measure their radiation, nor can they be handled without special protective equipment. The British industry has formed a nuclear instruments panel to foster the speediest possible development of this new branch, which makes diverse calls upon manufacturers, from Geiger counters to lead-glass bricks and periscopes.

Although the essential purpose of a scientific instrument is that of measurement to a specified standard of accuracy, its general appearance should not be neglected as a sales-promoting feature. What might be well accepted as a token of solidity and reliability. In contrast, American instruments have a much more modern appearance, and the same point can increasingly be made about the products of the resurgent German industry. A greater use of modern dull-coloured paint crinkle finishes and of chromium instead of brass must be expected. There may be little evidence of demand for this re-styling so far as the home market is concerned but the British share of world trade will be more difficult to maintain or expand if we stick too rigidly to traditional shapes and surfaces that give overseas buyers a 'first-sight' impression of obsolescence. Fashion and function are far removed features in a scientific instrument but in a competitive market the firm that can offer the best of both will book the orders.

Expansion has not been taken in the easy stride of short-term opportunism. It may be true to say that both world wars brought great and necessitous enlargement to the range and output of British scientific instruments, but the testing time of both post-war periods has shown that these gains were not temporary and fortuitous. The industry's research association is the oldest in existence for it was first formed in 1918; in recent years this association has shown particularly rapid growth, both in support and the variety of its activities. Another and a newer sign of long-term strength is the development of training facilities for new workers. Neither vigorous research nor vigorous demand can create opportunity if the supply of craftsmen and skilled workers declines. At present only two training courses are in operation and this is only a partial remedy; in any case the industry is not alone in its concern over problems of technological education.

If it was fair to say much earlier in this century that the British industry was slow to perceive its opportunities, it would certainly be unfair not to say now that both science and industry are being given excellent measure.

Notes & Comments

Glassware

IN these days of novelty we are apt to take the old and familiar materials for granted. Glass is a typical example but its contributions to science can hardly be excelled by any other substance. What could have been discovered without glass containers for chemical reactions, without glass for lenses in optical instruments? The new plastic materials and the new all-electronic instruments have a long journey to make before their service to scientific measurement and research can stand significantly by the side of glass. It is easy to assume that glass is much the same substance it always has been; in fact, it has made notable technological progress and there are today so many different types of glass that a single portmanteau word is hardly applicable. Certainly it is insufficiently realised, even by scientists, that in a relatively few years British optical glass has become the best in the world. Inferiority is an old legend. The principal reason for this has been the re-discovery of the Loch Aline sand deposits in Scotland, sand that after treatment has an iron content as low as 0.006 per cent. Today British optical glass producers have an essential raw material that is superior to the best Continental sources formerly regarded as indispensable.

An Outstanding Part

IN the production of scientific glassware research has steadily improved its place and it now stands side by side with craftsmanship and empirical knowledge. The control of raw materials and temperatures of melting and extracting has brought enormous improvement in basic quality. In the modern rise of British glassware the Department of Glass Technology at the University of Sheffield has played an outstanding part, and the introduction of new methods has been accelerated by the existence of the Society of Glass Technology. In 1938 Britain imported scientific glassware to the value of just under £200,000; in 1953 the import value was £74,000. This is not merely a reduction of 60 per cent. Making only moderate allowance for the changed goods-value of the £, it represents a reduction of about 85 per cent. Yet with the growth of science the demand for laboratory glassware must have risen very greatly. British exports of scientific glassware in 1938 were worth nearly £120,000; in 1953 the figure was £825,000. Again allowance for the £'s changed value must be made, but even after this a threefold expansion seems to have been obtained. These trade figures probably pass the soundest verdict upon British progress in scientific glassware production. Imports down by more than 80 per cent; exports up by 200 per cent. In a market where quality and performance must always be a major consideration of buyers, these changes cannot be dismissed as fortuitious reflections of war and post-war conditions.

US Apparatus

AT a meeting earlier this year of the Scientific Apparatus Makers' Association — America's SAMA — at Colorado Springs, considerable concern was expressed about the imports of microscopes and analytical balances from Europe, which were described as 'products of low wages.' On the theme that 'you can't stockpile skills,' a plea for greater tariff protection of the US industry was made. However, according to reports in *Chemical & Engineering News* (1954, **32**, 1980) this argument was objectively and firmly refuted by a spokesman for the Business and Defence Service Administration who pointed out that the American precision instrument industry had enjoyed an elevenfold increase in trade over the past 14 years *notwithstanding foreign competition.* In nine years up to 1947 the output of the apparatus industry expanded five times, with an annual increase of $100,00,000 each year. From 1947 to 1952 the output had risen by $250,000,000 each year. The US industry cannot feel dissatisfied with these figures which clearly show that the tide of prosperity and progress still

runs very favourably for them. If manufacturers in Europe are also securing a share of the home market in America, it is surely a sign that the demand for apparatus and instruments is so great that there is genuinely room for all. There can hardly be any grounds for predicting that the skill of apparatus makers will be lost because equipment made abroad creates unemployment. Indeed, the rate of expansion of the US industry has been so great that recruiting and training the skilled labour to support it must have constituted the biggest problem of all. In any case, it is not the experience of Britons that the US apparatus market is particularly easy to penetrate; on the contrary, like most highly specialised markets, it has proved to be a difficult export opportunity. The case for increasing tariff rates is small enough to require an optical instrument to view it.

Fertiliser Costs

AT a time when fertiliser prices are rising -- and most unfortunately when the world price for wheat is falling sharply — the review of productivity in the fertiliser industry (British Productivity Council, 1954, 28 pp., 2s.) is particularly timely. The current upward trend of prices is due to raw material factors that cannot be evaded. When coal rises, nitrogen, whose fixation calls for high fuel consumption, must also rise; and sea-freight costs for imported materials have hardened in recent months. Added to these is the general rise in railway rates within the country, a cost increase which many manufacturers did not pass on to farmers during the spring season. The new productivity review at least shows that the industry has steadily been doing all that could be expected in controlling the costs of production and thus reducing the farmers' bills for plant nutrients. Many of the recommendations of the British team that visited the US industry in 1949 have been adopted in British factories; some that have yet to be put into practice cannot be implemented by the industry alone but depend upon wider changes in agriculture, e.g., the introduction of a citric- or citrate-solubility standard for measuring the phosphate value of a fertiliser.

Price Swing & Roundabout

AN arbitrary selection of individual firms and factories is made in the appendix, which summarises the principal advances made by 17 factories. Mechanised handling, particularly of raw materials in bulk, is the dominant common theme. There can be little doubt that the labour time-cost per ton has been greatly reduced in fertiliser manufacture. But for this the steady rise in rates of pay for labour would have made all fertilisers appreciably dearer than they are. If man-hours cost more than they did three and five years ago, fewer are needed per ton of product. The costs of coal, transport, and raw materials are less controllable. Even in these cost-factors, however, progress has minimised the final economic effect that must be faced by farmers. The nutrient content of phosphatic and compound fertilisers has been steadily rising, particularly through the introduction of triple superphosphate. When a ton contains more plant-food, the transport cost on a nutrient basis is lowered. Nor can the older technological advance of granulation be ignored for this has enabled farmers to store without risks of physical deterioration and to economise in rates of application by placed drilling. Unfortunately few farmers are likely to study this new report. Although the prices of fertilisers are rising only by shillings per ton, and some prices not at all, the psychological reaction when farm produce prices are uncertain may not be favourable. Ironically, nothing can reduce the costs of farm production more strikingly than expansion in the rates and extent of fertiliser usage, and even if fertiliser prices were 50 per cent higher bold usage would still be highly profitable without any change in farm crop prices.

Legacy for Leeds

At a meeting of the Council of Leeds University on 16 June it was reported that under the will of the late Professor A. G. Perkin the university is to receive four-fifths of the residue of the estate. The bequest is to be known as the A. G. Perkin Bequest and the income will be used for the benefit of the Department of Colour Chemistry and Dyeing.

Cleaning, Care & Maintenance of Glass, Metal & Plastics Apparatus

by J. A. EDWARDS
(Laboratory Superintendent, Department of Chemistry, Birmingham University)

WITH the advance of the electronic age, the modern trend in the world of scientific apparatus seems to be more and more towards the ultimate enclosure of apparatus within a series of magic boxes provided with switches and knobs, the manipulation of which results in the movement of a needle across an arbitrary scale. Readings of the scale, coupled with mathematical calculations of a more or less abstruse nature, often afford results to the laboratory worker without the necessity of handling a great variety of separate pieces of laboratory apparatus. The technique of modern research and routine work is becoming, to a certain extent, a matter of knob-turning and mechanised calculation.

There still remains, however, and no doubt always will remain, the necessity for skill and care in the laboratory techniques employed by workers of one or two decades ago. The laboratory worker, whether in the fields of chemistry, physics or biology, with all the modern specialised sub-divisions and overlapping of these sciences, frequently finds it necessary to leave his electronic devices and proceed with apparatus similar in type to that used in his student days, although perhaps somewhat more complex.

A Disturbing Ignorance

It is disturbing to find that many workers in a laboratory either have forgotten, or never have acquired, the necessary knowledge pertaining to the cleaning and care of ordinary laboratory glass and porcelain. True, the advent of modern silicone greases, water repellents, defoamers, etc., now in common laboratory use, has widened the field, but there still lingers that attitude of mind which tends to place the cleaning of common laboratory apparatus on a par with work at the kitchen sink, instead of a necessary scientific exercise.

In certain of the larger and well managed American and British suites of laboratories where persons specially skilled in the art of cleaning laboratory apparatus are employed full-time, it is an inflexible rule that no bottles, flasks or other containers shall be sent to be 'washed up' unless they are empty. This is a wise safety measure, the onus being placed on the original user, a necessary precaution when it is realised that bottles and receptacles containing residues of sodium, organic solvents and strong oxidising agents may quite easily be assembled on the same washing up trolley.

Usually, however, the laboratory worker employed in research establishments carrying out a varied programme, or on routine work, finds himself personally responsible for the chemical cleanliness of his own apparatus, and it is to him that the following hints and methods are submitted, either as a reminder of the older techniques, or as information regarding the new.

Hardness of Water

In the case of ordinary laboratory glassware, the hardness of the water supply will affect the ease of cleaning to a greater extent than is generally realised. For instance, final washing of apparatus in a Manchester water supply would provide quite a different result from a final washing in, say, Wiltshire water.

In the cleaning of common apparatus we usually have one or more of the following problems before the final chemical cleaning of the glass: removal of insoluble solid deposits adhering to the surface of the glass; removal of oil or grease; removal of stains. It is desirable to mix a little detergent with the washing water and the addition of small pieces of paper when swilling out a flask often serves to scour the inner surface gently.

If a harder scourer is required, it may be found useful to use lead shot in place of the paper. The lead shot may conveniently be kept in a tin can, the bottom of which has been punctured with small holes somewhat like a colander. An old cocoa tin prepared in this manner, partly filled with lead shot and kept handy on the draining board, will save much time and temper in the removal of obstinate deposits. Needless to say, the lead shot may be used over and over again, being returned to the 'colander' to drain after each washing.

Detergents are usefully kept in a bottle fitted with a cork and jet for use vinegar-bottle fashion, this being a more economical method than merely pouring a quantity from an open bottle. If a liquid soap dispenser is used, it is advisable, in fact with certain detergents essential, that the detergent does not come into contact with any metal, otherwise corrosion may rapidly affect the efficiency of the dispenser. As is well known, proprietary detergents differ considerably in their lathering properties, and it must not be assumed that the wetting properties bear any relation to the amount of lather produced.

Removing Carbon Deposits

Carbon deposits are usually removed by soaking with a 15 per cent solution of caustic soda or potash, but if the carbonaceous matter is very obstinate, it will generally yield after standing in a mixture of two parts tri-sodium phosphate to one part sodium oleate in 16 parts of water. Another method of removing carbonaceous deposits frequently left in a flask after distillation of oils, is to heat a few grammes of solid sodium sulphate in the flask over a bunsen. This usually loosens the carbon residues, and after cooling the flask, it may be washed and drained in the usual way.

Although the proprietary abrasive powders are useful for cleaning purposes, they are apt to be messy and wasteful, quite apart from the fact that their continued use is bound to result in an accumulation of scratches which may prevent proper drainage, or act as minute pockets for unwanted substances difficult to remove. There is not yet on the market a proprietary product which combines the abrasive qualities of finely powdered pumice with the wetting properties of a good modern detergent.

The old fashioned stock cleaning solution of 120 g. sodium dichromate in 200 ml. water to which is added 1,760 ml. concentrated sulphuric acid, has much to recommend it provided due care is exercised in its use and storage, but it is obvious that an elementary knowledge of chemistry will serve to prescribe the limitations of this cleaning agent.

This cleaning mixture should be stored in a safe manner. A well glazed earthenware jug with a wide mouth is an excellent container, being easy to pour from while the wide mouth permits the return of used cleaning mixture without undue risk of spilling. These jugs are provided with a substantial handle and a broad base, and consequently they are not easily knocked over or cracked in use. Polythene jugs are also useful for this purpose.

The choice of cleaning agent must, of course, be determined by the nature of the contaminating substance, and again an elementary chemical knowledge is usually sufficient. For instance, permanganate stains are normally removed by treatment with concentrated hydrochloric acid or an acid solution of ferrous sulphate, whereas hydrochloric acid diluted with an equal volume of water will usually remove iron stains. Stains due to Nessler's solution respond to concentrated nitric acid, and albuminous incrustations may be removed with nitric acid or hypochlorite solution. In all cases, however, it is essential to complete the cleaning operations by final rinsings in distilled water, and if final drying is to be hastened, by blowing or sucking air into or through the vessel; it is most desirable that a simple but efficient scrubber be provided to prevent particles of dirt or oil from entering.

Excellent Cleaner

Fuming sulphuric acid is an excellent cleaning agent if used with care, and quite a small amount of acid will serve, provided the vessel is manipulated so that the acid comes in contact with all the surface. Treatment with fuming sulphuric acid should be followed by immediate emptying and rinsing. While common laboratory glassware is attacked by strong alkaline solutions and by hydrofluoric acid, it has been found that the addition of a small percentage of hydrofluoric acid to a solution of nitric acid in water, to which has been added a little detergent such as Teepol, provides a very effective cleaner in the cold. Glass or silica when contaminated with mercury or grease or carbonaceous material may be rapidly cleaned with this mixture. It is obvious, however, that this cleaner should not be used for graduated ware.

The use of silicones in many branches of laboratory work is increasing rapidly, especially as wetting and antifoam agents, as greases for ground glass joints and stopcocks, and for the protection of instruments against rust and corrosion. This is mainly on account of their chemically resistant properties and their very low vapour pressure at higher temperatures. These properties,

although valuable, raise two important problems, namely, the necessity for a perfectly clean and grease-free glass surface *before* the application of the silicones, and the possibility of having to remove the silicone lubricant or film from the glass surface after use. *Before* the application of a silicone film, glass may be cleaned by means of the dichromate-sulphuric mixture, followed, after thorough rinsing in water, by washing in pure carbon tetrachloride to remove the last traces of grease. Care should be taken to ensure that the glassware is kept free from dust while drying and until the silicone film has been applied.

Silicones may generally be removed from glassware, after excess has been wiped off with a cloth, by soaking in fuming sulphuric acid or in warm decalin for an hour or so, followed after draining by a good rinse in acetone. Another method is to soak the glass in concentrated sulphuric acid for a couple of hours; then after draining the glass is washed with clean concentrated sulphuric acid before being given a final washing in water. The necessity for this second washing in clean sulphuric acid before the final washing in water is apparent when the molecular changes occurring during the process are considered.

A further method that has been found successful is to first remove any traces of water by giving a preliminary rinse with alcohol, followed by several rinses in chloroform, and finally a cleaning with dichromate-sulphuric mixture to ensure the removal of contaminating materials other than silicones.

Mercury Columns

Levelling tubes open at the top and containing mercury columns are often difficult to keep clean, with the result that the mercury meniscus becomes dusty and dirty, which makes readings difficult, quite apart from the inaccuracies creeping in due to the small air pockets which may be caused by dust and dirt adhering to the inner wall of the tube. The inside of the levelling tube may be kept in a clean condition by allowing about half an inch of syrupy phosphoric acid to float on top of the mercury. This, while riding up and down the tube as the mercury level rises and falls, scours the glass, thus providing a clean wall through which the mercury meniscus may be clearly observed.

Certain brands of graduated glassware employ fused-in fillers which render the graduations easily readable throughout the life of the apparatus, but many workers prefer the clear cut whitened graduation lines. After much use these graduation lines and figures become difficult to read as the white substance used for filling the original etched marks becomes dirty or washed out. The graduation marks may be restored to their original cleanliness quite easily.

Filling Graduations

First, the glassware is cleaned in dichromate-sulphuric mixture; this is usually accomplished by standing in a tall jar of cleaner for a few minutes, taps uppermost, and then rinsing in several changes of water or by transferring to another tall jar through which a stream of water is passed. After draining, a paste of zinc oxide is rubbed into the graduation marks, using the finger to apply the paste. The glassware is then set aside to dry slowly for a few hours. When the zinc oxide is seen to be perfectly dry and hard, excess is removed by rubbing with clean tissue paper. It is important to apply the paste by means of the finger and to use tissue paper to remove excess. It is a mistake to use a cloth or cotton wool.

Another method is to substitute for the zinc oxide paste a mixture of boiled linseed oil, plaster of paris, and white lead, which is rubbed into the graduations in the same way. After allowing to dry, any excess is removed by rubbing with a cloth.

Black graduation marks may be intensified or renewed by first cleaning thoroughly and then rubbing a paste of manganese dioxide and boiled linseed oil into the lines. After drying, the excess paste is removed by rubbing with tissue paper. Lamp black suspended in shellac is sometimes used in place of the manganese dioxide-oil paste, but in this case the excess should be rubbed off before it is quite dry.

Delicate cells used for optical work, mirrors and lenses are best cleaned with a proprietary lens tissue paper, but if it is necessary to use a liquid, then pure Castile soap or a fine detergent may be used with advantage, provided there is no risk of damaging the cement, in which case it is better to play safe and use a pure powdered medical soap. The corners of these cells are prone to harbour grease and dirt, which may be removed by means of an orange

stick without undue risk of scratching the inner surface of the cell.

Plastics, such as Perspex, are replacing sheet glass in many ways and for a variety of obvious reasons, but the comparatively soft surface of Perspex receives small scratches. After much handling, dust and grease lodge in the interstices of these scratches, the net result being an unpolished dirty appearance with consequent lack of transparency. Several proprietary preparations are available for the purpose of re-polishing, most of them good, but it will usually be found that Perspex may be restored to its original clear transparent condition by polishing with a liquid metal polish such as Brasso.

Black and other dark panels may be given a 'new look" by the use of a trace of ordinary black boot polish, vigorously applied with a soft cloth, followed by careful polishing with a chamois leather or Selvyt cloth.

Stand Up to Sterilisation

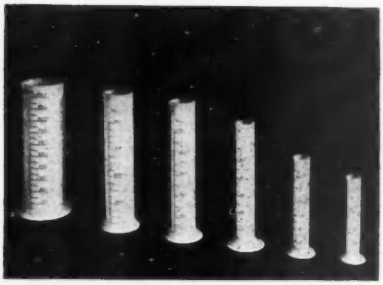
A brightly polished steel surface, if not to be handled, may be preserved by the application of a thin film of pure anhydrous lanolin. The lanolin may be applied either direct or dissolved in benzene. The benzene evaporates, leaving a thin film of lanolin over the surface of the steel as a protection against rust and corrosion. The benzene-lanolin mixture may be applied by means of a small spray with advantage. Small steel instruments used in surgery and dentistry, and other small hand tools which require frequent sterilisation, are sometimes successfully treated with silicone oils in order to maintain them in a rust free condition. It is found that instruments so treated will stand up to several sterilising periods without complete loss of lubricating and corrosion resisting effect of the silicone oils.

Graduation marks in metal should be treated with great care, otherwise they will be irretrievably ruined. The renovation of these graduation marks is generally considered to be a skilled job for the instrument workshop where the apparatus would be first cleaned of old lacquer by treatment in hot caustic soda, but it is often possible to bring the marks back to something approaching their original clearness by first cleaning thoroughly with a tooth brush dipped in methylated spirits, then brushing over with hot melted beeswax to which has been added a little lamp black. After cooling, the process is repeated and the excess finally wiped off with a soft cloth.

A simpler method for the brightening and cleaning of graduation marks in metal is to rub the metal scale with a dry cloth wrapped round the index finger and dipped in fine bone black. The bone black applied in this way serves both to brighten the metal of the scale and cause the engraved lines to stand out clearly.

The arch enemies of most optical apparatus are dust and grease. Dust may be minimised by the use of the semi-transparent plastic dust covers now so readily obtainable from laboratory furnishers. Grease usually accumulates due to the continual handling of optical apparatus with the bare hands. This grease in turn encourages dust to adhere to the instrument, and so the vicious circle persists until the time arrives when a major overhaul, due to dirt and corrosion, becomes necessary, with the consequent expense and inconvenience of having the apparatus out of commission for a period of time. A little forethought and a sense of responsibility on the part of the user will prevent much of this.

The above are but a few of the many methods found successful in the cleaning and maintenance of laboratory apparatus. Most established workers have their own favourite methods, some well known and others not so well known.



The rapidly-expanding range of laboratory apparatus in polythene and PVC manufactured by Rediweld Ltd., Crompton Way, Crawley, Sussex, includes these very useful measuring cylinders in capacities of 25, 50, 100, 250, 500 and 1000 ml. They are in polythene, lightweight, chemically resistant, and, of course, virtually unbreakable

Recent Developments in Laboratory Design

by E. W. DOBSON, (Laboratory Fittings Division, Baird & Tatlock (London) Ltd.)

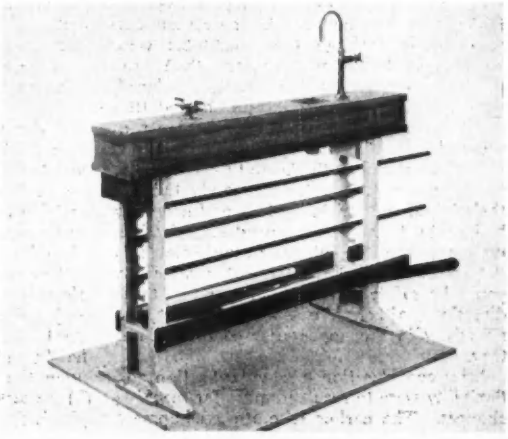
IN the years before the war, laboratory design had made steady but unspectacular progress, mainly in details of equipment and in a general improvement in standards, but to outward appearance a laboratory furnished in 1939, for the practice of almost any of the well-established sciences, would have differed but little from a similar purpose laboratory furnished fifteen years earlier.

The fifteen years which have elapsed since 1939 have witnessed a considerable departure from this unspectacular development, and most of the progress has been concentrated into the last five years.

During the war period, laboratory facilities had to be expanded rapidly, but such expansion was largely restricted to those sciences directly connected with the prosecution of the war, and the general shortage of materials prevented very much experimental development in any direction in which existing methods and designs could give reasonably adequate results. Nevertheless, it was clear to designers that unless they began to think afresh on some of the basic requirements of their subject, and to take advantage of some of the new materials becoming available, scientific progress would be hampered by out-dated and inadequate accommodation.

Three aspects of laboratory design made special demands upon attention. The country as a whole was poorer than in pre-war days, and although money was available to meet genuine needs, there was little to spare for embellishments that had no immediate practical value. New equipment had therefore to be functional, and not merely a more spectacular variation of an existing basic design. Secondly, war-time production experiences had shown that some degree of standardisation might well be applied to the manufacture of laboratory equipment, with advantages in cost and in the more efficient use of manufacturing facilities. At the same time, standardisation carried to excess would have resulted in rigidity of design, and in a period of rapid development, flexibility was an all-important requirement. Thirdly, new materials, e.g. plastics, were slowly becoming available, and some of these were clearly to become of value in laboratory equipment manufacture.

For various reasons, the first consideration, that of economy, had only a small immediate effect upon design, although it did have some effect upon the laboratory equipment industry as a whole by limiting the scope of some of the more ambitious building projects. Flamboyance had never been a characteristic of laboratory design;



Unit for use as central service unit for either wall bench, single-sided or double-sided bench

Unit in use as double-sided centre bench, with working surfaces at 2 ft. 7 in. height

in the earlier days science was to some extent regarded as a 'poor relation' in education and industry, so that insufficient money was made available to enable any of it to be spent on display. Gradually also, designers learnt that excess of decoration was a positive hindrance in the working of the laboratory, and thus the joint result of financial restriction and the necessity for plain, hard-wearing equipment was to bring about an almost puritan simplicity of design —puritan, that is, in comparison with the contemporary non-laboratory furniture of the period.

With such a background, there was thus little room for the practice of economy by omitting superfluities—in general there were no superfluities to omit, and some of the enforced war-time expedients of using substitute materials had not been over-successful, so that although the substitutes were sometimes basically cheaper than the originals which they temporarily displaced, their lack of wearing qualities showed that the dearer materials were often cheaper in the end.

There was thus little desire to promote the use of alternative materials merely because their initial cost might be less, and economy had to be found in improved organisation, or in consideration of basic requirements to determine whether component dimensions could be safely reduced. Progress in these directions, although not without effect, did not show in the appearance of the laboratory.

Joint consideration of standardisation and flexibility were to result in more far-reaching changes. The earlier laboratory equipment tradition had been one of 'tailor-made' articles, to suit the known requirements of a particular user, at a particular time and for a particular purpose. Such articles were often very efficient, but being individually designed and made, they were sometimes difficult to adapt to meet subsequent changes in conditions.

Some laboratory requirements are so unusual that there will almost certainly always have to be a proportion of individually designed and manufactured equipment in any laboratory engaged upon anything other than completely routine work. But for the majority of the equipment, standardisation was clearly a development which would repay attention. This meant the adoption of some system of unit construction so that the variety of components could be reduced, but the quantities of the retained components much increased.

It would thus be possible to attain the advantages of batch-production—the potential demand was generally too small to permit the introduction of true mass-production methods—and the immediate difficulty was the design of a unit system which should be as flexible as possible, both to cover a wide range of initial requirements, and also to be capable of easy rearrangement to meet changing circumstances.

The principle article of equipment in almost any laboratory is the working bench and the constituent parts of this are (a) a stable working surface—the length, width, height and materials of which are dependent upon the particular function of the bench; (b) the service lines and outlets; (c) convenient places for storage of equipment and chemi-

cals; and (d) a rapid means of assembling apparatus. All of these requirements may change independently of each other, and a successful unit system must make provision for such independent alterations. It cannot be claimed that any designer has yet met these requirements in full, but a system introduced five years ago by Baird & Tatlock Ltd. went a long step in the right direction, by providing for a stable working surface supported independently of the under-bench storage accommodation, ready access to service lines, and a wide range of dimensionally interchangeable standard under-bench units and accessories.

Being a system of standardised units rather than of standardised benches, it was possible to meet a considerable range of laboratory requirements by rearrangements of units, and it was also possible to increase or reduce bench lengths without any great difficulty. The system also allowed for the use of front-controlled service outlets—the absence of such facilities being a notable defect in other unit systems. This unit system was so far in advance of any other which had previously been marketed, that it rapidly attained considerable success. Its ease of transport and assembly enabled an appreciable export business to be initiated and expanded, so that today a large number of overseas laboratories in newly developing countries are as well equipped as most laboratories in the United Kingdom, and are not the assemblies of crude, make-shift, locally-produced articles that they might well have become.

In well-established overseas areas also, the system found favour, and certain countries which previously looked to the US to supply laboratory equipment now purchase much of their equipment from this country.

As will have been seen, there were certain basic requirements which were not fully met by the system in its initial stages of development. It was not possible to vary bench height or width, or to change the material of the working surfaces. Facilities for the erection of larger apparatus had also not been developed to any extent. Even in its present state, however, the equipment is adequate for a wide range of laboratories, but experimental work is now in progress so that the 'BTL' system will very shortly be available in an alternative form which, while it retains all of the advantages of the present arrangement, will also allow for the easy alteration of bench height and width (without the necessity of entirely changing the under-bench units or dismantling the complete bench), the exchange of working surface materials, and the conversion of any bench into a service rack, with or without an attached apparatus rack.

These developments will make it possible to effect very wide alterations in the use of the laboratory while still retaining the initial equipment, a considerable saving in time, and an even greater saving in money. For research laboratories, or any other type of laboratory where the nature of the work may be subject to change, the slightly higher initial cost of the new alternative form of

Unit in use as double-sided centre bench, with working surface on one side at 2 ft. 7 in and drawer unit fitted, and working surface at 3 ft. on other side

the system is likely to be found well worthwhile.

The next line of development lay in the use of materials which, although not necessarily new in themselves, were new in their application to the manufacture of laboratory equipment. Timber was the traditional material for this purpose, and indeed, teak is still probably the best general purpose bench top material yet found. For some purposes, however, timber as a constructional material for the carcase of the bench, or for the units in a unit system, had certain defects, and the fall in timber quality during and after the war constituted a spur to efforts to develop alternative materials.

Timber qualities have now risen again, and for much laboratory construction it is still a very satisfactory material, but early experiments with steel were generally successful, so that for laboratories where cleanliness or non-absorbent surfaces are desirable, steel has now become an accepted medium of construction. Also for laboratories in hot or humid climates, and in other cases where the dimensional instability of timber is a disadvantage, steel has made rapid strides—although due attention must be given to the rust-proofing and high-grade finishing of the steel. The unit system earlier mentioned was developed as a steel system, although it is also available in timber form.

A still more recent development is in the use of plastic surfaces for under-bench units. This must still be regarded as an experimental matter and it is as yet too early to make any precise recommendations, but there is a definite future for such materials provided that due regard is paid to their chemical and physical limitations, i.e. it cannot yet be claimed that a plastic-surfaced unit is any more universally successful than is a timber or steel unit. However, plastics is still a young industry, and designers will be ready to take advantage of any new development which will extend its usefulness for laboratory equipment construction.

The developments which have now been sketched are common to the whole field of laboratory design, but progress is also being made in more restricted directions. Although often of importance, they can only receive passing mention here. Attention is being paid to improvements in the design of fume cupboards and fume extracting systems, and with the increased use of air-conditioning, balanced-draught fume removal systems are likely to become more permanent. Although somewhat expensive in the first instance, these give efficient fume extraction with the loss of minimum quantities of that rather expensive commodity—fully-conditioned air.

Specialised features are also being developed in equipment for laboratories in all branches of atomic development. Such equipment is still largely individually designed, and would require an article in itself, but mention may be made of the use of strip-lacquer and similar finishes which can be removed easily in the event of contamination.

The mobile laboratory, although having its origins in the first world war, is now becoming widely recognised as a valuable means of providing laboratory facilities for occasional or periodic use, remote from any centre, and such laboratories, fully equipped with all services and other aids, are being designed and built for an increasing range of purposes.

Science grows apace, and laboratory designers will not relax their efforts to see that so far as lies within their powers, this growth is not hampered by inadequate or out-moded equipment and furnishing.

Seventh OCCA Exhibition

ARRANGEMENTS have been completed by the London section exhibition committee of the Oil and Colour Chemists' Association for the Seventh Technical Exhibition to be held at the Royal Horticultural Society's Old Hall, Vincent Square, London, S.W.1, from 15 to 17 March, 1955.

Theme of the display may relate to new products, new knowledge of existing products, and their uses or, in suitable cases, existing knowledge not generally available in the consuming industries. The committee have decided to continue the use of a shell scheme for the stands which will be slightly larger than the 1954 stands, in that 1 ft. greater depth has been added, thus making the floor area of the stand units 8 ft. wide by 6 ft. deep.

Companies who have not previously exhibited and would like to have their names submitted to the committee for consideration, should write to the general secretary, Mr. R. H. Hamblin, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4.

The Development of Automatic Titrators

by J. R. MAJER, Ph.D., D.I.C., A.R.I.C.

A GREAT deal of effort has been expended in the past few years in the elaboration of mechanical aids for the analytical chemist. Two of the successes of this crusade have been the commercial production of the single-pan automatic weight-loading balance, which can display the weight of an unknown sample upon illuminated scales within a few seconds, and recording thermo-balances. With the latter it is possible to follow the change in weight of a sample in a furnace and thus to determine accurately without supervision the time of complete ignition, or the rate of oxidation of heated samples. Much of the pioneer work was carried out by Clement Duval and his co-workers and is discussed in his recent book. In addition to the operations of weighing and ignition, now fully automatic, the analytical chemist spends a great deal of his time in the procedures of filtration and titration, and it is not surprising therefore to find so much ingenuity expended in attempts to relieve him of the burden of the latter task.

Ideally the automatic titrator consists of three parts, a dispensing valve admitting the titrant to the unknown solution, a sensing mechanism which identifies neutrality or equivalence point and transmits a signal to the dispensing valve, and a recording device which notes the volume of titrant added. There has been a great diversity in the form of the dispensing valve, which may be the solenoid-operated stopcock of a conventional burette, an electromagnetic plunger, a motor driven syringe, or may be eliminated altogether. The sensing mechanism operates on a property of the solution which changes abruptly at the equivalence point, and the choice of property can be very wide. It can include optical properties such as density or refractive index, electrical properties such as the radio frequency resistance or the potential of immersed electrodes, the temperature or the light emitted.

Commercial models of automatic titrators with a high degree of accuracy, and suitable for almost all of the titration methods normally employed by the analytical chemist, have been available in the United States for several years. Development models have been shown at the Physical Society exhibitions in this country. Of the large number of possible methods of identifying equivalence point which are suitable for automatic operation, two alone have received sustained attention: the potentiometric and the photometric methods. The latter was suggested as the sensing device for an automatic titrator over a quarter of a century ago; but little attention was paid to it until recently, and the first really successful automatic titrator was based on the experience gained in potentiometric titrations, and utilised the potentiometric principle in the determination of equivalence point.

Potentiometric Determination

Lingane described an apparatus in which the titration cell contained two electrodes, a standard calomel electrode, and an indicator electrode which could be a bright platinum wire. The two electrodes and the solution which is being titrated form a cell and current is drawn from this cell to operate a standard potentiometer recorder. The titrant is added from a syringe, the plunger of which is moved by a synchronous motor having a range of speeds. A mercury switch is included in the motor circuit and this is tripped by the potentiometer recorder, the equivalence point potential being chosen beforehand as the tripping position. Anticipation of the equivalence point is obtained by placing the indicator electrode close to the nozzle of the syringe so that the momentary excess of titrant raises the potential, causing interruption of the flow, which is resumed only when stirring has removed this excess.

The relative positions of the syringe tip and the indicator electrode must be adjusted experimentally for each separate reaction, the rate of reaction determining the distance between them for optimum accuracy. In addition the sensitivity of the potentiometer must be set for each separate reaction, so that the potential change occurring during the titration is covered by the scale.

The addition of titrant to the unknown solution is slow, the maximum being 4 ml. per min., and this is necessary to avoid overshooting of the equivalence point. In order to achieve greater speed of addition

it is necessary to add the bulk of the titrant rapidly and the remainder at a much slower rate. It was suggested that if the motor driving the syringe could operate at two speeds, the second much slower than the first, the titrator would more nearly imitate successful manual operation. This effect could be achieved by the inclusion in the potentiometer recorder circuit of a second mercury switch to operate at a potential near to that of equivalence point and switch in a fixed resistor in the motor circuit.

Applications of the Apparatus

Titrations of ferrous and vanadyl ions with ceric ions have been carried out with this automatic titrator using a platinum wire as the indicator electrode. This was replaced by a pure silver wire in titrations of chloride and iodide with silver nitrate, and it was found possible to carry out successive titrations of chloride and iodide in a single solution. Acid-base titrations have been carried out with low resistance electrodes such as the hydrogen, quinhydrone and antimony electrodes; but if a glass electrode was used as the indicator then a linear electronic amplifier had to be interposed between it and the recorder. A commercially available direct reading *p*H meter was found quite suitable for this purpose.

The expensive recording potentiometer has been replaced by an electronic triggering circuit (Schmitt) which can be adjusted to switch off abruptly at a predetermined potential, and to switch on again if the potential is lowered. The sensitivity of this circuit, i.e. the change in input signal required to actuate a relay, is ± 3 mV, or if the power supply includes a voltage stabilising device, ± 2 mV. In addition to the normal range of titrations the automatic titrator has been found ideally suited for carrying out titrations with air sensitive material, such as the reduction of Ti (IV) and Fe (III) with chromous chloride.

A unit based on the Lingane design and incorporating a direct reading *p*H meter was found to be suitable for controlling the addition of acid or base (so as to maintain a constant *p*H) to a system in which hydrogen ions were being made or consumed. Another apparatus describer as a dual purpose titrator and dispenser used a modified electric record player as a timer, and an electronically controlled pressure regulator to maintain a constant flow of reagent. The equivalence point was indicated by a galvanometer connected to two half-cells in the solution. The unit was claimed to be particularly suitable for titrations in non-aqueous solution and the concentrations of mercaptans, sulphides and salt in petroleum samples have been measured at the rate of 100 assays per hour.

One of the chief difficulties in the construction of automatic titrators is the provision of means for stopping the flow of titrant quickly enough to prevent over-titration. Some method of anticipating the equivalence point, either by the indicator system or by some external system, is required. The reason for this need is that the response of indicator systems is never spontaneous. Factors determining the rate of response are the efficiency of stirring, the rate of addition of titrant, the shape of the vessel with respect to the indicator electrodes, the point of addition of the titrant, and the sluggishness of the reaction.

A number of different types of indicator system exist, each with a different response time, and so an anticipation arrangement which is independent of the indicator system is to be preferred. Such a device has been described and consists of a solenoid operated pipette which withdraws a portion of the sample before titration. The remainder is then titrated to equivalence point at a rapid rate and the portion returned to the sample, titration continuing at a reduced rate until the second equivalence point is reached. The portion withdrawn must be sufficient in size to react with the excess of titrant produced by the overshooting of the first equivalence point, and the second titration must be carried out slowly enough to allow indicator systems to come to rest. The solenoid operated pipette may be connected conveniently to the base of the titration cell with narrow bore tubing.

Photometric Determination

The photometric method of determining the equivalence point has been neglected until recently in favour of the potentiometric method, its sole champion being Muller, who has stressed that the actual rate of attainment of electrode potential sets a limit to the sensitivity of autotitrators employing electrical sensing systems. The solutions which have been suggested for this problem include the provision of elaborate servo-systems which add titrant at a

diminishing rate as the end-point is neared, and the juxtaposition of the indicator electrode and burette tip, a system which has been discussed above.

The objection which has been raised to photometric equivalence point determination is that it is unsatisfactory for turbid or highly coloured solutions. This is a visual criterion and if sensitive photomultipliers are used in conjunction with strong light sources the difficulty may be overcome, since it is merely a question of passing enough light through the titration cell, the photometric increment at indicator change being independent of solution density. The advantages of photometric methods are that the commercial photocell has a high impedance and is easily matched to a high-gain amplifier, while with quite simple equipment it is possible to distinguish differences in density which are imperceptible to the unaided eye. In addition, there is a larger signal/noise ratio with photometric indication than with potentiometric indication.

Coloured Ions in Solution

A large number of reactions can be followed by the use of coloured indicators and there are also many ions whose concentration in solution may be followed photometrically. Ceric ions, for example, show a strong absorption at 320 mμ, and since cerous and arsenic ions have no similar absorption it is possible to follow the titration of arsenious acid with ceric sulphate photometrically. Similarly, the tribromide ion has maximum absorption at 270 mμ, but its high molar extinction permits its measurement in solution up to 330 mμ so that it is possible to titrate the unsaturated constituents in petroleum fractions by the addition of acid to a bromate/bromide mixture and to determine the end-point photometrically.

An instrument described recently by Muller was intended for the continuous titration of small and sudden additions of acid to a system. A dichroic beam-splitter was placed in the light path and two photocells were used. When a two colour indicator such as bromthymol blue was used, the beam-splitter transmitted blue light into one photo-cell and reflected yellow light to the other, thus increasing the sensitivity of the instrument to the colour transition caused by small changes in the *p*H of the solution.

The two photocells drove a twin cathode follower circuit, the output of which was fed to the recorder and simultaneously to a servo-amplifier. The output of the latter operated a small motor driven syringe adding the titrant to the solution. For any influx of acid the photometric system produced a deflection which was recorded, and simultaneously the servo system was set in motion by the same error signal. When the titration was complete the error signal disappeared and the recorded trace returned to zero deflection.

A similar device was used by James and Martin in their separation of volatile fatty acids by gas-liquid partition chromatography. The carrier gas, saturated at intervals with acid vapour, bubbled through a titration cell containing indicator. A beam of light passed through the solution on to a photocell. As the acid dissolved in the solution the indicator changed colour, the change in density being detected by the photocell. The error signal was amplified and allowed to operate an automatic burette containing caustic soda, delivering it to the titration cell until the original conditions had been restored. A mechanical coupling of a writing pen to the syringe drive of the automatic burette allowed the titration to be followed and recorded.

A similar result could be achieved by coupling a commercial recorder to the photocell output. The photocell was chosen so that it responded directly to the colour change of the indicator (phenol red for fatty acids and methyl red for volatile bases) without the interposition of a filter.

Dead Stop End-Point

The Karl Fischer method of determining moisture involves an end-point in which the solution colour changes from yellow to light amber, and experience is needed before full accuracy can be attained. Also the change is less visible with turbid or highly coloured solutions, so that an instrumental indication is to be preferred. The potentiometric method is not suitable because of the need to maintain anhydrous conditions, which are incompatible with the presence of a calomel reference electrode and a salt bridge. Despite these difficulties commercial instruments based on this principle are available.

If a small potential difference is applied to a pair of platinum electrodes sufficiently

large to oppose the back EMF produced by polarisation, at the end-point the electrode is depolarised and a large increase in current is obtained. This is much easier to detect than the change in EMF, which is only of the order of 10 to 20 mV. The advantages of this method of end-point determination (dead stop) are that the approach of the end-point is indicated by rapid swings of the galvanometer, while equilibrium is reached very rapidly. Although the method is very sensitive, some form of automatic control is necessary, for the galvanometer swings become very rapid near the end-point, and it is difficult to distinguish between a galvanometer excursion and the true end-point.

Again, when the sample is not soluble in the solutions used, water must be extracted from a solid phase (dairy products, streptomycin, insulating materials, etc.). In this case to obtain maximum accuracy a rigid reproducible discipline must be employed and this is best carried out by means of an instrument. A suitable unit consists of a conventional burette, the stopcock of which is controlled by a solenoid, a sensitive relay which may be tripped by a current of 15 μA and a pair of platinum electrodes. The relay, which may consist of a microammeter fitted with contacts, operates a power relay connected to a time relay, which differentiates between transient and true end-points and controls the solenoid which operates the stopcock.

Three Lights Indicate Progress

The progress of the titration is indicated by three lights, the first flashing on when the titration is started, the second as the end-point is neared, and the third when the titration is finished and the meniscus steady. The microammeter also gives an indication of the state of polarisation, and the sensitivity may be adjusted, as can the timer which differentiates between true and transient end-points. Most end-points may be considered permanent in 30 seconds. With sluggish samples, e.g. suspensions, the period may be lengthened to 60 seconds; but if on the other hand side reactions occur, then the time may be reduced to 15 seconds to prevent interference. A titration may take from one to three minutes and the accuracy is that of the burette itself.

The dead stop method has also been used for determining the end-point in the titration of arsenic with electrolytically generated bromine, while the polarised electrodes have also been connected to a relay switching in the output of an oscillator so as to give an audible warning of the approach of the end-point.

Electrolytic Generation of Titrants

The analytical chemist spends a good deal of his time in making up and standardising solutions, and many workers have suggested that the titrants should be produced in solution electrolytically, this method also obviating the storing and accurate volumetric measurement of standard solutions. This form of titration was carried out in 1938 when solutions of hydrazine and hydroxylamine were titrated with an electrolytically prepared solution of bromine obtained from acidified potassium bromate, with a 100 per cent current efficiency. The method was called coulometric titration to distinguish it from coulometric analysis, since it could be applied to substances which cannot be made to react quantitatively at an electrode themselves, and hence cannot be determined by direct electrolytic methods.

The standard solution is thus replaced by a standard electric current and this must be electronically regulated to a constant value for a measured time. The end-point may be determined amperometrically (dead stop) but unfortunately this limits the generating current to 10 mA, for higher currents induce parasitic currents in the indicator electrodes, making the end-point difficult to identify. This low current corresponds to 10^{-4} milli-equivalents per sec.

Larger samples of potassium dichromate and ceric sulphate have been titrated with electrolytically generated ferrous ion at the 100 mA level using potentiometric detection of the end-point with a platinum-tungsten electrode pair. The internal generation of the titrant has the additional disadvantages that the sample may not contain substances which undergo reactions at the electrode, and so it has been suggested that the titrant should be generated in a separate cell and then passed to the titration cell.

An apparatus which has been described incorporates a constant delivery burette whose jet is connected to a T piece, in either arm of which is a coiled platinum electrode. The space between is filled with glass wool, one arm of the T leading to the titration cell and the other to the drain. The products of electrolysis are prevented from mixing and are swept into the vessel without loss or

reaction. The flow is adjusted to 0.1 ml. per sec., the current is switched on and adjusted, and then the titration cell is placed under the delivery arm. The timer is started and the titration carried out to end-point when the timer is switched off and the stopcock closed. This technique allows the dead stop indication of end-point to be used as the indicator electrodes are isolated from the generating pair, while a wide range of concentrations may be dealt with by adjustment of the current. The process may be made automatic by the use of a *p*H meter operating a relay.

Suitable for Continuous Operation

It is an advantage in the constant current device if the load current does not pass through the regulator circuit, since this permits the use of currents above 100 mA. Recording may be achieved by attaching a potentiometer recorder to the *p*H meter when potentiometric determination of end-point is used. This type of instrument is particularly suitable for continuous operation and a model was used to monitor the concentration of mustard gas in air. The sample was drawn through a cell where the gas dissolved and the air carried over liquid to an outer cell, where it was returned after filtration. The titrant was bromine generated electrolytically from acidified potassium bromate in the titration cell at the same rate as the gas was absorbed.

The electrolysing current was supplied by an electronic power amplifier, the output of which was controlled by the potential of the solution as measured by a calomel and platinum wire pair in such a way that diminution in the amount of free bromine caused additional electrolysing current to flow. Measuring and recording instruments could be placed in series with the amplifier.

Photometric determination of end-point may also be used with electrolytically generated titrants, but the method has certain limitations. Only those systems giving a colour change at the end-point, or to which indicator may be added can be studied while other factors causing changes in the absorption of the sample, such as precipitation, bubble formation or colour change on dilution, must be avoided. A photocell relay circuit initiates and terminates the generating current according to the response of the photocell, and simultaneously operates an electric timing clock. In this way arsenite has been titrated with electrolytically generated iodine, the end-point being detected by the appearance of the brown colour of the free iodine.

Phenolphthalein is a satisfactory indicator for acid-base titrations and in all coulometric titrations with acids and bases the electrolyte used is one whose ions do not discharge at the generating electrodes. Thus, hydrogen ions are produced at the anode by the discharge of oxygen, and hydroxyl ions at the cathode by the discharge of hydrogen. The chief difficulty with this method of end-point determination is the interference of gas bubbles produced at the generating electrode. An additional absorption is thereby produced, so that with titrations in which less light is transmitted before than after, the additional density causes overtitration, while in the reverse case a premature termination of the titration occurs. The effect is less serious in the latter case, since when the bubbles disperse, the titration is automatically reinitiated and the accuracy is thus unimpaired.

The effect of bubble formation may be minimised by the use of two photocells in opposition, each viewing one half of the titration cell and being equipped with suitable filters. The accuracy with this form of titration can be as good as 0.04 per cent.

Thermometric Titration

Titrations in which the end-point was determined by measuring the temperature of the solution were carried out as early as 1921. Curves were obtained by plotting the temperature of a titration cell against the volume of titrant added, and these showed significant inflections in the vicinity of the equivalence point. The technique has been applied to a variety of titrations including oxidation-reduction, precipitation, acid-base and complex forming reactions. Most of the early results were not sufficiently accurate for analytical procedure, but with the use of a Dewar flask as the titration vessel, and a Beckmann thermometer for temperature measurement, a fair degree of accuracy was obtained. However, the need for making many careful temperature measurements during the course of a single titration discouraged development.

Recently it has been suggested that the Beckmann thermometer may be replaced satisfactorily by a glass covered thermistor, whose output may be fed to a recording

potentiometer. Commercially available thermistors have a low heat capacity which gives rapid response and a high sensitivity in ohms per degree Centigrade. The sensitivity of the whole instrument may be adjusted by altering the potentiometer, a suitable average value being full scale deflection for a temperature rise of 5°. Because it is only temperature differences which are measured exact calibration is not necessary.

Constant Flow Necessary

The thermistor is included in a simple bridge circuit, the output of which is fed directly to the potentiometer recorder. One axis of the recorder chart measures temperature and the other time, since it is driven at constant speed. The burette must therefore deliver titrant at constant flow, and the principle used is that flow through a capillary tube is dependent upon the head of liquid only (at constant temperature and solution density). The temperature of the titrant in the burette is kept to within 0.05° by means of a thermostatted water jacket, while a Mariotte bottle and a large head of liquid ensure constant flow. The disadvantage of this system is that it is bulky and difficult to clean when a change of titrants is necessary. The motor driven syringe which has been used in commercial instruments such as the Precision-Dow Titrator has been claimed to be preferable. The accuracy for acid-base titrations is a few parts per thousand, and it is not impaired by the addition of filter paper pulp to give a thick slurry.

The limitations of the thermometric method are that the reactions studied must be rapid, or the end-point is displaced and indefinite. The rapid and adequate mixing of large volumes of liquid is difficult, and if small volumes are used, then evaporation effects impair the accuracy. The temperature rise may be difficult to measure if solutions are too dilute, for example the titration of 1 meq. in 200 ml. of water gives a temperature rise of only 0.07°. If the heat of reaction is small great care must be taken to equalise the temperature of the sample and titrant, or the temperature rise will be masked; the heat of dilution must also be small compared with the heat of reaction. With strong acids and bases the lower limit of concentration is 0.002 N with an accuracy of ± 2 per cent, but when weak acids or bases are used the heat of ionisation must be taken into account. With the exception of hydrogen fluoride weak acids evolve less heat than strong acids.

One of the chief advantages of the method is that it may be applied without difficulty to titrations in non-aqueous solution, and in fact it is more sensitive in organic solvents because of the lower specific heat. Again, Lewis or aprotic acids and bases such as aluminium chloride and dioxane may be titrated as easily as other types. Among the titrations which have been carried out are the precipitation of zinc, lead and manganese as the hydroxide, and calcium, strontium and mercury as the oxalate, complex forming reactions such as the reaction of cobalt, copper and nickel with ammonia, and nickel, zinc and cobalt with cyanide, and mercury with iodide and oxidation-reduction reactions such as the oxidation of ferrous iron with permanganate, and arsenite with bromate. The concentration of water in concentrated acids may be estimated by titrating with fuming acids.

Other Methods

There are two other methods of end-point determination suitable for automatic operation. The first of these involves the detection of light emitted by a chemiluminescent indicator. There are a variety of substances including aminophthal-cyclic hydrazide, dimethyl diacridylium nitrate and siloxene, which emit light when they are oxidised in solution. The first of these, known as luminol, will only do so in alkaline solution, so that when a titration of a sample of acid is carried out with an alkali in the presence of luminol, the solution glows at the end-point. The indicator mixture used contains hydrogen peroxide and haemoglobin as a catalyst, and the end-point may easily be detected in opaque solutions. The output of a photomultiplier may be connected to relay or recording circuits as described before.

A good deal of attention has been paid to high frequency titrimetry in recent years. In this technique the effect of the change in capacity of the titration cell upon an oscillator is measured, either as a change in frequency or anode current. Once again a recording potentiometer or a relay circuit may be used to control the flow of titrant to the cell. While this method has the advantage that the electrodes do not come

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Instruments for Industry on Show

SIMA's Display at Production Exhibition

SOME of the ways in which instruments have been of assistance to the technical, pharmaceutical, glass, ceramic and allied industries will be demonstrated on the stand of the Scientific Instruments Manufacturers' Association of Great Britain at the Production Exhibition, at Olympia from 7 to 14 July.

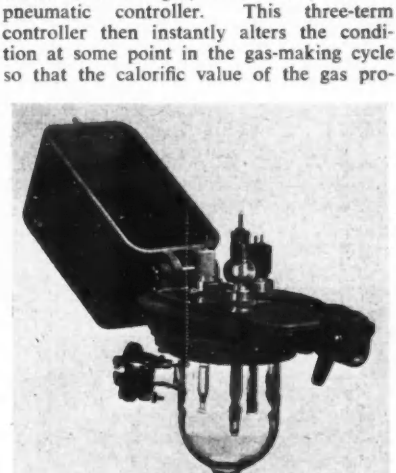
Although the requirements of these industries differ in some particulars, they have a certain basic similarity in that all require the control of certain variables such as *p*H, temperature, humidity, concentration, pressure, etc., to achieve optimum results.

The wide range of instruments available for the measurement and control of *p*H will be represented by three typical exhibits by W. G Pye & Co. Ltd., of Granta Works, Cambridge. These are the Pye universal *p*H meter (which can also be used as a millivoltmeter where desired), the Pye miniature *p*H meter, and the Pye industrial *p*H amplifier. The first two are used mainly for the direct measurement of acidity or alkalinity, though the universal *p*H meter can also be used to drive an external indicator, controller or recorder without loss of performance. The miniature *p*H meter is battery-operated and can be taken to the actual sampling position rather than taking the sample to the laboratory.

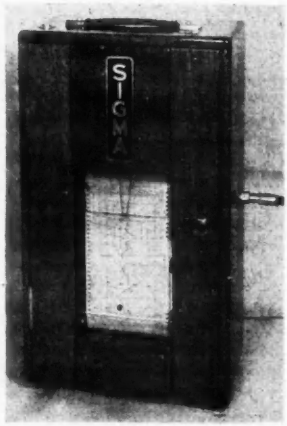
Where it is desired to exercise a continuous control over *p*H rather than merely to measure it, the industrial *p*H amplifier will normally be employed. This instrument, which has a stability of ± 0.02 *p*H for all normal variations of mains frequency and voltage, is enclosed in a flameproof case and is provided with automatic temperature compensation.

Exhibits by C. F. Casella & Co. Ltd., of Regent House, Fitzroy Square, London, W.1, will make a special feature of their temperature and humidity indicators and recorders for applications ranging from normal laboratory conditions down to −70 or −80°. The Casella frost point hygrometer for measuring humidity down to such temperatures will provide a particularly interesting exhibit for those visitors whose manufacturing problems involve maintaining exceptionally dry conditions in parts of their plant. Normal industrial applications which will be indicated on the stand are for conditions such as the production of oxygen where the moisture in the gas must necessarily be kept to a very low figure.

The importance of correct instrumentation in obtaining combustion efficiency will be stressed by the Sigma Instrument Co. Ltd. of Letchworth, Herts. Typical of the items covering the production and use of gas in the Sigma-Kent recorder for the automatic control of the calorific value of gas. This instrument consists of a Sigma Mark 2 recording calorimeter, made up of a gas-flow regulator, measuring device and recording mechanism. The regulator supplies gas to the measuring device in which it is burnt at a constant rate. The heat resulting from the combustion of the gas is then led through a system of tubes which feeds a signal, dependent on the heat obtained from the gas, to a Kent Mark 20 pneumatic controller. This three-term controller then instantly alters the condition at some point in the gas-making cycle so that the calorific value of the gas pro-



Pye continuous-flow electrode assembly for pH control



Sigma Mark V recorder for indicating and recording pressure or vacuum

duced is brought back to the desired value.

Also to be shown is the ultrasonic thickness gauge made by Dawe Instruments Ltd., of 99 Uxbridge Road, Ealing, London, W.5, designed to enable readings to be taken of wall thicknesses up to 12 in. when one side only of the wall is accessible.

Other exhibitors on the stand are the Sperry Gyroscope Co. Ltd., of Great West Road, Brentford, who will aim to show, in relation to their Zero Reader flight director, how good designing can aid production and facilitate servicing and testing by the user; and Tensometer Ltd., of 81 Morland Road, Croydon, who will demonstrate the Hounsfield Tensometer and other equipment for testing and recording the mechanical properties of metals, fibres, rubber and films, etc.

Automatic Titrators

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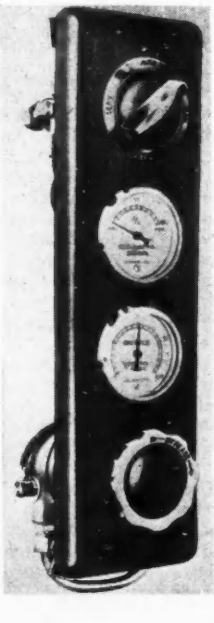
in contact with the solutions there are restrictions on the concentration of reagents. With simple oscillators of the tuned-anode tuned-grid type operating at frequencies up to 30 Mc. per sec. maximum sensitivity is obtained with concentrations of 0.002N. With more complicated oscillators the value rises to 0.05N at 100 Mc. per sec., while to use 0.2N solutions quarter-wave concentric line oscillators operating at 360 Mc. per sec. are necessary.

Next Year's BII Exhibition

ORGANISERS of next year's British Instrument Industries' Exhibition to be held from 28 June to 9 July are aiming to present a more attractive programme than ever before, and the fact that it will overlap the Tenth International Printing Exhibition should prove an added advantage from the point of view of the attendance of visitors from overseas.

Response from exhibitors, it is stated, has more than justified the decision taken to select Earls Court, where all stands are to be sited on the same floor, as the meeting ground of the Exhibition, which has hitherto been held at Olympia.

The Exhibition is sponsored jointly by the British Electrical and Allied Manufacturers' Association, the British Industrial Measuring and Control Apparatus Manufacturers' Association, the British Lamp-blown Scientific Glassware Manufacturers' Association; the Drawing Office Material Manufacturers' and Dealers' Association and the Scientific Instrument Manufacturers' Association.



THE George Kent auto / manual / test / service station is for use with the Mark 20 air-operated controller. It comprises a 4-position plug - type selection valve, a regulator position gauge, an auto / manual balance gauge and a manual pressure regulator. When the switch is at 'test' control is manual, but the automatic mechanism is functioning, enabling tests to be made; at 'service' the air supply to automatic control is cut off, and repairs may be made without affecting manual control.

Instruments of the Year

AUTOMATIC instrumentation in the laboratory, known for years to those in this country who read the American journals and who attempted, sometimes successfully, to construct their own apparatus, has at last reached commercial development on a significant scale. In industrial processes, too, automatic control has attained sufficient proportions to justify the setting-up of a separate NPL division to study it. The most important developments of the past year have been in this field.

Although weighing has not yet been made completely automatic, recent years have seen much reduction in the time taken to make a weighing ; **Oertling's** balance Model 125A, for example, is claimed to be at least 40 per cent faster than the original 125. Operation has been simplified, and a single dial applies weights to a value of 1 gm. Automatic weight loading to 10 gms. is achieved with the Model 128, which was developed for very rapid weighing of samples which have all the same weight within 5 gms.

These and other Oertling balances, normally fitted with Releas-o-matic mechanism but available without, were first exhibited at the 1954 Physical Society Exhibition. The continuing popularity of these balances is indicated by the fact that in some instances prices have been reduced during 1954.

A number of modifications have been made to the **Towers** Model 101 balance, designed to give it greater stability and accuracy. The optical system has also been changed, and is now a completely new unit housed in a compact dust-proof case to protect the mirrors from corrosion. The zero adjustment is optically operated.

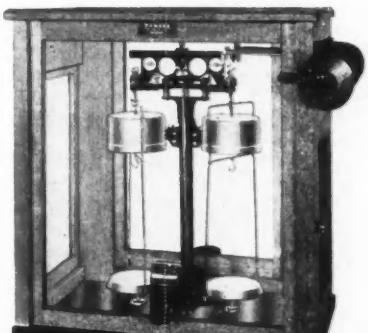
New Whatman filter paper products during the year include a new grade of paper and two specially cut patterns. The new grade is specially for the standardised assay of antibiotics by the paper disc method and is available as ' AA ' discs 1.3 cm. in diameter. The paper is thick, and a disc serves as a carrier of a specific volume of antibiotic culture fluid. Since the diameters of the discs are standard, the zones of inhibition are proportional to the amount of antibiotic present.

The new patterns of paper are specially cut for paper chromatography and electrophoresis. CRL/1 is a small sheet 21.3 × 11.0 cm. cut to form 12 strips 1.5 cm. wide with a 3 mm. slot between each strip. The slots are 9 cm. long so that a 1 cm. band joins top and bottom. The paper may be formed into a cylinder and stood in a small dish and covered with an inverted 600 ml. beaker. The method, which was originally developed for geochemical surveys, is very useful for carrying out multiple analyses rapidly and quantitatively.

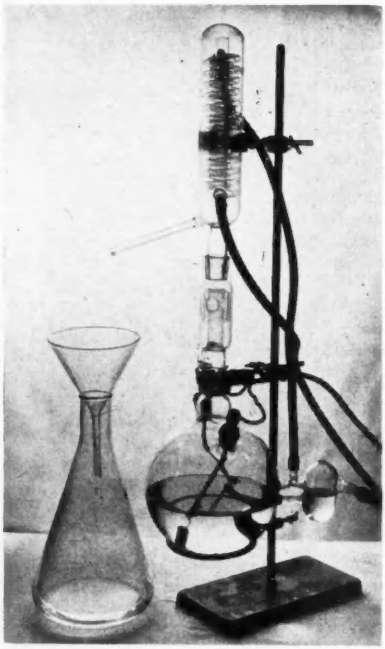
Pattern CE/1 consists of a standard size sheet 18¼ in. × 22½ in., which is cut along one of the shorter edges with a serrated knife so as to form a line of V-shaped tongues ; in electrophoresis the solvent dripping from the bottom of the sheet with separated fractions of test solution may be collected in a series of small tubes. Both patterns of paper may be obtained in any of the usual grades from **H. Reeve Angel & Co.**

Halfway toward automatic apparatus is the **Cambridge** titration apparatus. This outfit, originally developed for the analysis of steels, may, however, be employed in most volumetric analyses. It is particularly useful in determining the end-point in deeply coloured solutions. Operation, however, is manual.

The standard electrode system includes platinum and calomel electrodes, a thermometer, and two burettes (one for back titration)



The re-designed model of the Towers 101 balance



Loughborough all-glass high purity water still, with improved pattern of splash trap

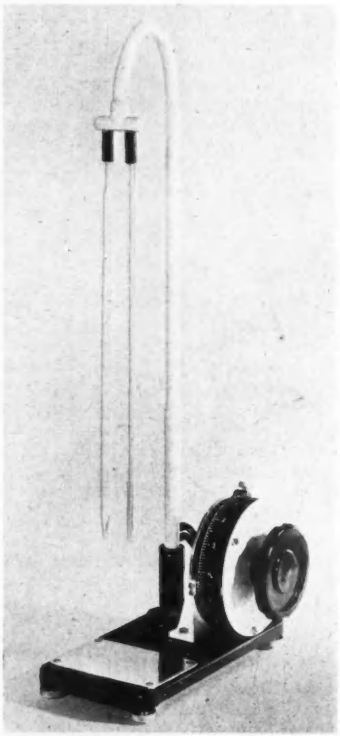
mounted together on a movable frame which may be raised or lowered by a handle at the side of the base. The apparatus is fitted with a magnetic stirrer, the speed of which may be varied at will. Determination of end-point is by potentiometer and moving-spot galvanometer, and special reference cells may be supplied for special titrations. The apparatus is adaptable for the Karl Fischer estimation.

Glass developments from the **Loughborough Glass Co.** include an improved model of their all-glass water still. The new pattern has an improved spray trap, and produces pyrogen-free water well within BP standard. Rating of the heater is 3 kW, and, at a water consumption of 82 l. per hr., output of distilled water is 4 l. per hr. A new type of soxhlet solvent trap, which saves time and reduces fire risk ; and a 9 × 18 in. industrial condenser with five coaxial coils of total area 12.5 sq. ft., are other new items.

Jencons have produced a simple one-piece crucible holder which incorporates its own funnel in a tapered neck to fit various flask sizes, and have improved a technique for sealing quartz windows into borosilicate or other glass tubing.

Routine pipetting of liquids, besides being a tedious and time-consuming operation, can be dangerous with a poisonous or radioactive liquid. G. A. Bacon and T. W. Burrows of the Ministry of Supply Microbiological Research Establishment have conceived a piece of apparatus which eliminates hazards and increases accuracy in the hands of semi-skilled personnel. This is the 'Pipettor,' which is being marketed by **L. A. Steiner.**

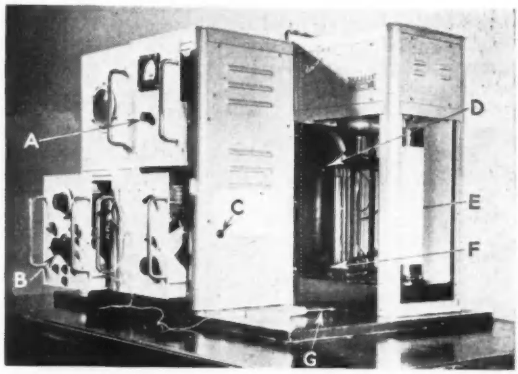
It consists essentially of a hollow glass ring containing mercury and placed in a drum.



Steiner 'Pipettor' fitted with two sizes of pipette

Towers automatic distillation apparatus

A. Volume follow-up sensitivity control
B. Heater control
C. Coarse standardising control
D. First drop lamp and photocell
E. Chart drum
F. Volume follow-up lamp and photocell
G. Thermocouple



Standard pipettes can be attached to the glass ring, so that when the drum is rotated in one direction, liquid will be drawn up into the pipette. The liquid will be held while the drum is stationary, and expelled when the drum is reversed. The volume reading is taken from the pipette itself, but a removable auxiliary scale is provided on the drum, and in conjunction with an adjustable stop this will allow rapid and consistent repetitions of a required volume.

The apparatus is available in three sizes : for 0-10 ml. pipettes, graduated in 0.1 ml. ; for 0-1 ml. pipettes, graduated in 0.01 ml. ; and a combined unit for both pipettes.

First really automatic apparatus in this review of recent developments is the **Towers** automatic distillation apparatus. This was developed on the designs of the Shell Refining & Marketing Co., to carry out laboratory test distillations as specified in IP method 123/49B and ASTM designations D86 and D158. The normal procedure occupies about 35 minutes, during which time a laboratory worker has to be in attendance to maintain distillation rate and make measurements of temperature and volume.

With this apparatus, results can be obtained in 15 minutes without the constant attention of an operator, and they are given in the form of a graph on a chart. It is claimed that reproducibility of results obtained with this equipment in the hands of semi-skilled worker is at least as good as can be obtained by a careful analyst using the standard manual equipment.

Although it is quite possible for normal observers to match any colour by an additive mixture of three colours, it has been found that different observers require different proportions to obtain a match. These observer differences are frequently larger than the colour differences which can be discriminated by a single observer.

By increasing the number of matching colours to six, however, the mixture required for a colour match is very nearly independent of the observer. An instrument for this purpose was first described by Donaldson (*Proc. Phys. Soc.*, 1947, **59**, 554) and a commercial model is now being manufactured by **Bellingham & Stanley**. All the instruments are standardised and calibrated at NPL.

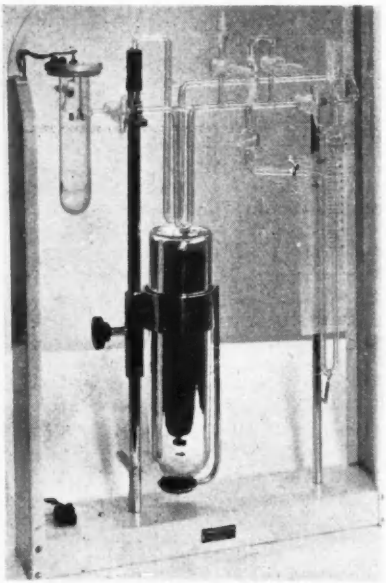
Another interesting Bellingham & Stanley instrument is a sugar and oil refractometer. It is extremely easy to use, as it is only necessary to insert one or two drops of the material to be tested between the prisms of the instrument when the edge of a well-defined shadow can be seen through the eyepiece. This cuts across a scale giving sugar concentration or oil scale values, which can easily be converted by tables into refractive index. A temperature correction device is provided for use with sugar solutions.

The products of **Edwards** are always of great interest to the chemist, and one of their latest is particularly so. This is the micro moisture determination apparatus, which will give accurate determinations down to 10^{-6}g. The principle of the apparatus is that water, drawn as vapour from the specimen under high vacuum, is condensed as ice in a refrigerated trap. The ice, after isolation of the specimen

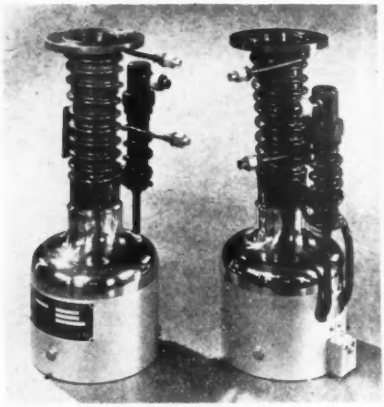
and withdrawal of the refrigerated container, re-evaporates, causing a pressure rise in the system, which is of known volume. The pressure rise is measured in a U-tube oil manometer calibrated directly in grams of water.

Specimens may be inserted sealed in ampoules; the top is cracked off under vacuum by an electrically-heated wire, and displaced by a magnetically controlled plunger in a sidearm. The apparatus is of hard glass throughout and supported by a chromium-plated stand.

Another new instrument from Edwards is the 2M4 'Speedivac' diffusion pump. It is claimed that this vapour pump will maintain a speed 30-40 l. per sec. at better than 10^{-6}mm. Hg. (with liquid air trap) even if the performance of the backing pump should fall as low as, or only be capable of, 0.1 l. per sec. at 35 mm. Hg. This means that an ordinary water jet pump may be used.



The Edwards micro-moisture determination apparatus: left, the container for the sample, with heater for ampoule cracking and deflector; centre, trap for water condensation; and right, manometer



Two views of the 2M4 mercury diffusion pump

The Cartesian manostat which Edwards make under licence from Emil Greiner of New York is available in both glass and metal models. Made of stainless steel, the manostat is suitable for operation between the pressure limits of 5 mm. Hg. and 60 psi.

First announced a year ago, the production model of **Baker's** new interference microscope was on show for the first time at the recent Physical Society Exhibition. This instrument, which has already aroused much interest, may well revolutionise research in certain fields. The interference-contrasted images of unstained material can be viewed either in colour or in monochrome, and the sensitivity is such that phase changes as small as 1/300 wavelength can be measured.

The microscope can be supplied for obtaining interference images by either 'double focus' or a 'shearing' system. The latter has sometimes proved preferable to the standard double-focus system because there is much greater spatial segregation between the object feature and the reference area, thus permitting quantitatively useful results to be obtained for correspondingly larger features. The shearing system objectives are better for making sensitive measurements on separated features, but not so well suited for continuous specimens.

During the year, **Flatters & Garnett** have made a number of improvements to their 'Mikrops' industrial microprojector. They are now able to provide attachments for polarised light, and the instrument can also be equipped with an intense mercury vapour

arc lamp. The projector finds many uses in all branches of industry, since it can largely replace the microscope for routine examination of microscopic structures.

Four years' experience in the manufacture of thermostatic water baths has convinced **Techne** that an electronic relay suffers from one serious disadvantage—the life of the thermionic valve is short compared with the long periods of operation to which most baths are subjected. Their latest bath employs pneumatic amplification ; while air control is the most widely used in the chemical process industry, this is probably the first time it has been employed in a thermostatic bath due to the lack of a suitable compressor.

It has been found possible to use the suction provided by the stirrer as a source of power and, in this way, a compact unit with an operating force of about 225 g. has been constructed. Temperature is controlled within .025°.

MSE, who, it is claimed, now make the largest range of refrigerated centrifuges in the world, have recently introduced a new type of centrifuge head. This is the high-speed swing-out head, which combined the horizontal sedimentation characteristic of swing-out heads with the performance and totally enclosed form of a high-speed angle head. Two sizes are available, one for use with the MSE Superspeed unit, and one for use with the MSE 'High-Speed 13' and 'Super-Speed 20' centrifuges.

It is undoubtedly in laboratory apparatus for biological methods that some of the most important advances have been made in recent years. The low inertia Warburg apparatus now being made by **Townson & Mercer**, for instance, is a great improvement on the old models. The basic principle is that a shallow circular bath takes fourteen standard manometers round its rim, and the whole assembly can be rotated by hand to bring any manometer in front of the operator. This means that the apparatus can be situated in the corner of a room.

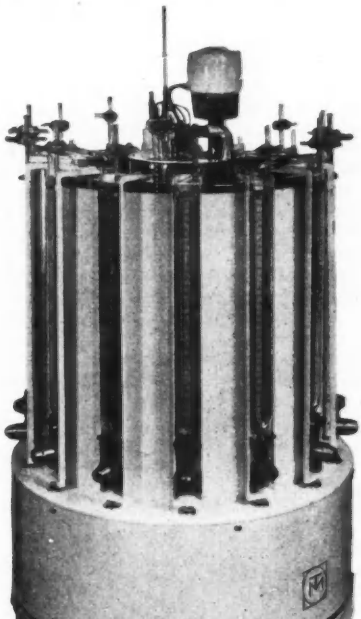
Each manometer is oscillated independently on its vertical axis by a special spring-operated arm working from a central eccentric. By this means no heavy masses are moved and the operation is nearly silent. Any manometer may be stopped independently of the others merely by holding it.

A new type of temperature control with infra-red feed back enables much smaller quantities of water to be used, yet the accuracy is claimed to lie within 0.015°. A further advantage of the small bath is that it only takes 15 minutes to rise from room temperature to 37°.

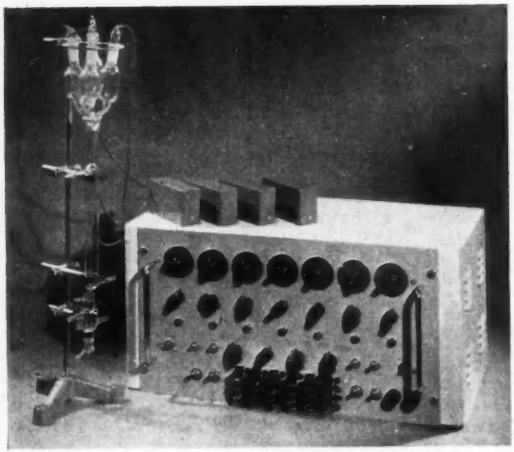
An instrument for automatic biological assay of drugs developed in the Pharmacology Department of University College, London, is being made by **Casella (Electronics)** under licence from NRDC. The apparatus is designed to improve the accuracy, speed and convenience of measurements of drug activity made on isolated organs.

Each response of the tissue involves various routine manipulations such as adding the drug, recording tissue contraction on a moving drum, emptying and refilling the isolated organ bath and allowing an interval for recovery of the tissue ; further antagonistic or potentiating drugs may be added at some stage of the cycle.

The principle consists of controlling the flow of drug and washing solution into and out of the organ bath by the use of electro-



Townson & Mercer low inertia Warburg apparatus



Casella 4-point drug assay apparatus

magnetic valves which compress rubber tubing. The apparatus is particularly suitable for three- or four-point assays involving the repetitive addition of a number of drug solutions.

The separation of proteins by electrophoresis is now standard practice in clinical laboratories. The procedure consists of immersing a paper strip in the buffer solution contained in a bath of convenient design. An electrical potential is then applied along the paper, causing the different proteins to migrate along the paper at different rates. After a suitable time, the paper strip is removed from the bath and the proteins fixed to the paper by heat coagulation. The strip is then immersed in a dye solution, the dye is washed out and there remain stained bands, showing the position and relative concentrations of the individual protein fractions.

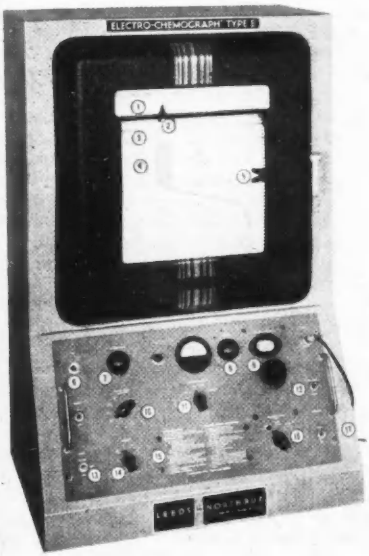
Up to now evaluation of the results has posed certain difficulties. At first quantitative estimates were obtained by elution methods. Subsequently a method was developed of making the strip translucent and reading the optical densities of the bands. The latest improvement is the 'EEL' scanner made by **Evans Electroselenium**, which enables the readings to be plotted directly, giving a graph of dye concentration along the strip.

To accompany the scanner, a suitable power unit and specially designed bath have been developed. The power unit, which includes a mains transformer, full-wave rectifier and smoothing condenser, operates directly from 230 V 50 c mains and will deliver a current of any value from 0 to 10 mA, the voltage range being 0-400. The bath has a transparent cover which may be used, if desired, as the dye-bath for staining the strips.

Polarographs are now standard equipment in many laboratories, but the accuracy of most

Complete apparatus for electrophoresis: scanner, power unit and bath

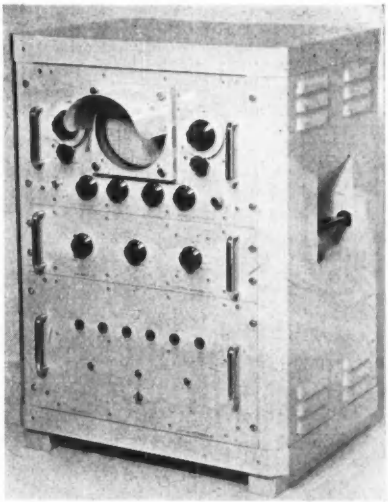
recording models is usually of the order of ±1 per cent for full scale deflection, and at intermediate points on the scale the error may be considerably greater. Some workers at the School of Pharmacy, Chelsea Polytechnic, desired to measure diffusion currents with an accuracy of ±0.1 per cent, and a suitable manual instrument was designed. This is now being made on a commercial scale by **Doran.** In applications in which precision, high current sensitivity, and permanence of calibration are of primary importance, a potentiometric



General view of the Leeds & Northrup 'Electro-Chemograph E'

manual instrument offers advantages over the more costly automatic models.

For routine analytical work, however, there is no doubt that the automatic instrument is preferable. The first pen-writing instruments to be put on the market in this country were the Tinsley, now sold by **Evershed & Vignoles,** and the **Cambridge.** A new unit for the latter has recently been produced, which enables polarograms of simpler form and up to twenty times the sensitivity to be obtained. This is the 'Univector,' which superimposes a pure AC voltage on the standard DC voltage. The



The Southern Instruments cathode ray polarograph

record pattern does not follow the customary step formation but rises from the base line to a height which is a direct linear function of the concentration, after which it returns to the base line at zero current.

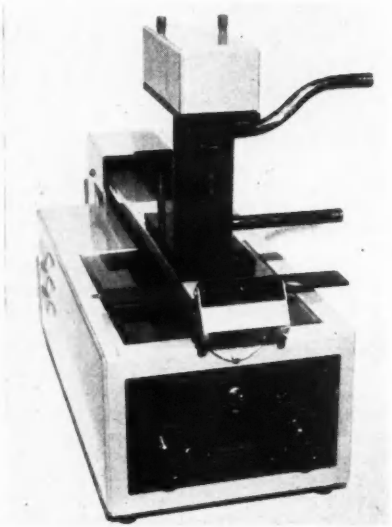
Detection of many substances down to concentrations of 0.1 mg. per 1. is possible, and concentrations of 1 mg. per 1. may be determined with an accuracy of 5 per cent. Thus it is possible, for example, to measure 0.2 per cent Cd in Cu without preliminary chemical separation.

A polarograph which has long been familiar to the readers of *Analytical Chemistry* is the 'Electro-Chemograph E,' which is now available in this country from **Integra, Leeds & Northrup.** It is claimed that so simple is the operating procedure that complete instructions for a typical determination can be engraved on the instrument panel. The apparatus is fitted with a motor-driven polariser, whose synchronous motor drives a 5-in. slidewire, applying polarising potential to the cell at the rate of 200 mV per min., or ten minutes for the complete 2 volt span.

A handsome new instrument from **Southern Instruments** is a cathode ray polarograph, which greatly extends the scope of polarographic technique. With increased sensitivity, resolution and speed the amount of chemical

separation and concentration required is reduced, making possible determinations which are very difficult to carry out in any other way.

It is claimed that the sensitivity is up to 100 times that of a recording polarograph, full scale deflection representing 2×10^{-8} A, and permitting determinations of concentrations of a fraction of a μg. per ml. Ions differing in half-wave potential by as little as 0.1V may be determined in the same solution, and a derivative circuit will allow even closer waves to be resolved. The entire potential sweep is carried out once in the lifetime of every drop.



Continuous flow attachment in position on the Baldwin transmission densitometer

Light is becoming increasingly important in the laboratory, both as a tool and as a participator in reactions. Another valuable new '**EEL**' instrument is a light integrator, designed to provide a means of measuring the quantity of light received over a period of time.

This apparatus, which was first shown in prototype at the Physical Society Exhibition this year, has applications in the textile, paper and dyestuffs industries, when it is desired to illuminate samples for an extended period, and in agricultural research when plants are grown under controlled conditions.

The light receiver may take the form of an opal globe with internal arrangements to make the reading virtually independent of the angle of incidence of the illumination, or a plane matt receiver, the instrument being cosine corrected. In all cases optical filters may be fitted as required.

Light from the receiving surface falls on an emission type photo-cell which operates a cold cathode discharge tube at intervals dependent upon the illumination received. Each discharge is counted on a four-figure electromagnetic counter, the rate of count thus being proportional to the illumination. The instrument operates on 230 V 50 c single phase mains, and is fully stabilised against mains or frequency variations.

A continuous flow cell has been made available for use with the **Baldwin** vacuum-cell photometer. This fits above the standard transmission densitometer, and consists of a Bakelite tube of any convenient length with a transparent Perspex disc at each end. Two brass pipes are let into the side of the tube, as near the ends as possible, and connected to suitable rubber tubing through which the liquid flows.

With a light source at one end of the cell and the photocell at the other, any change in optical density can be measured and recorded. In tests so far it has been possible to measure 0.05 ppm. of impurity in water and a difference in SG. of 0.001 in oil.

The **Unicam** SP.400 spectrophotometer is an improved model of the SP.350, and another recent development is the infra-red spectrometer (see THE CHEMICAL AGE, 1953, **68**, 980).

Most important advances made during the past year by **Hilger & Watts** have been in the simplification and acceleration of spectrochemical analysis by electronic methods. Two principal types of apparatus have been completed. The first is an attachment for the medium flat-field quartz spectrograph, which consists of a casing containing an array of fixed slits of special construction. These may be set very close together, if necessary, and aligned with spectrum lines concerned in the analysis being made. Associated with each slit is a condensing mirror system which concentrates the selected spectrum lines each on a separate photomultiplier cell. Provision is made for eleven such systems.

The output from the cells is fed to a compact measurement and control unit containing high

quality capacitors which are charged by the output from the photomultipliers until that which is associated with a standard reference line has received a predetermined charge. The rest of the capacitors are then connected in turn to a meter which indicates their respective charges and thus, by calibration, the actual analysis.

A second instrument, called a 'polychromator,' embodies a 3 metre grating, in the focal curve of which 30 separate measurement channels can be interposed. The control console is similar in principal to that used in the 11-channel attachment, but it embodies complete test circuit arrangements for checking the operation of the measuring channels, as well as spare channels.

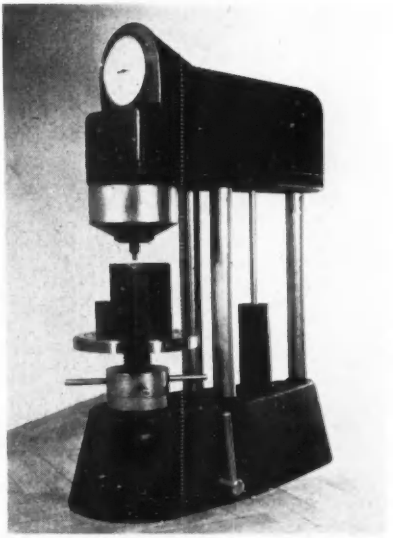
Other improvements include a greatly improved arc and spark apparatus ; a special switch for reversing polarity of discharge on electrodes ; a new design for the Uvispek spectrophotometer ; and a new model of prism mount which makes location more precise.

What is described as 'a relatively inexpensive instrument' is a mass spectrometer developed in conjunction with AERE Harwell, and now offered by **Daniel Varney**. The instrument is of high sensitivity, accuracy and resolution, and is of 180° focussing type with a fixed magnetic field of 1500 gauss and a variable accelerating voltage. This can be selected by direct switching for any mass number between 16 and 57, and is extended to mass 90 by a continuous control.

The pumping system is a 2-in. oil diffusion pump backed by a two-stage mechanical pump, giving a pumping speed of about 30 l. per sec. at less than 1 micron. All parts of the spectrometer are easily demountable for repair, and all sensitive electron parts trip off in the event of an electrical failure.

In the realm of industrial testing several interesting pieces of apparatus have recently been introduced. **H. J. Elliott** have an improved Ströhlein apparatus for the estimation of carbon in steel ; and **Everett, Edgcumbe & Co.** have a portable tester for insulating oil. This latter conforms fully to BS. 148 : 1951, and has continuous smooth variation from 0 to 50 kV. Two types of test cell are available, with electrodes through the top cover and with electrodes through the side walls.

Shown at the 4th Gauge & Tool Exhibition in May by **C. Tennant & Sons** was the Bracknell direct-reading hardness tester. This instrument gives loads of 60, 100 or 150 kg., which may be varied instantly by finger control.

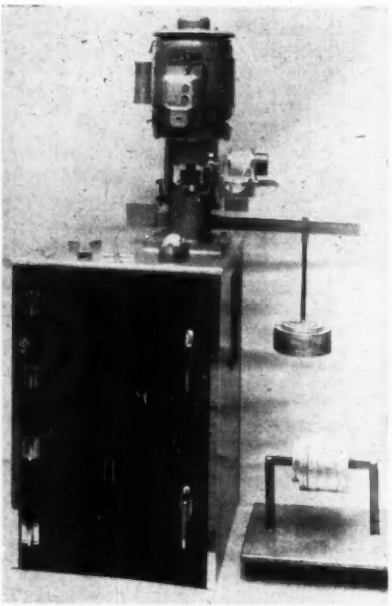


Bracknell direct reading hardness tester, suitable for bench use

A 4-ball extreme pressure lubricant testing machine is being made by **Stanhope** under licence from the Shell Petroleum Co. In this apparatus a sliding motion under high pressure is produced between steel or other test specimens, simulating closely the contact conditions which occur in gears and metal cutting operations. The machine is most commonly employed for the assessment of gear lubricants containing EP additives, and for this purpose the test specimens are steel balls, but for testing oils for other purposes balls of different materials, or test pieces of other shapes, may be substituted.

The apparatus is specified in the method of test for the load carrying capacity of low temperature greases to Ministry of Supply Specification DTD.844, and for the load carrying capacity of EP lubricating oils to Specification DTD.581. It also meets the requirements of US Specification VV-L-791(e).650.3.

An instrument, sponsored by the International Standards Organisation and developed at the request of the Dunlop Rubber Co., is being produced by **Nash & Thompson** for the



Stanhope-Shell 4-ball extreme pressure lubricant testing machine

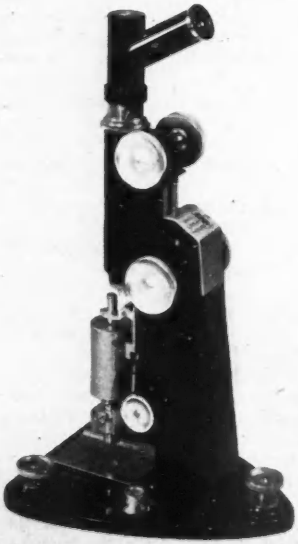
micro hardness testing of rubber. The apparatus will accommodate specimens from 4 mm. to 45 mm. diameter, and from 1 mm. to 35 mm. thick. The indentation of a ball-ended pin, measured in 0.01 mm. units, gives the BS hardness number, which may be converted to international hardness degrees by reference to BS.903.

Another interesting Nash & Thompson instrument is an electrolytic polisher for use with metallurgical specimens. The standard method of preparing specimens is to mount them in a plastic mould and then polish with successively finer grades of abrasive paper. The disadvantage of this procedure is that unless great care is taken in the final stages the true structure of the metal will be disguised by distortion and spreading of the surface layers. By making the specimen anode in a specific solution, however, the distorted surface layer may be removed by electrolysis.

The Nash & Thompson instrument is the first of its kind to be made in this country, and has a working range of 0-70 V with a maximum current of 5 A. Cathodes are available in copper, aluminium and stainless steel.

Another of the instruments shown at the Physical Society Exhibition in prototype, but not yet in production, was the **Pye** miniature *p*H meter. This is $7 \times 5 \times 3$ in., and is intended both for laboratory use and for plant and field testing. It has a range of *p*H2-12 on a scale marked in 0.2 units, and the discrimination is 0.05.

The circuit, which is stable in operation and independent of valve and component changes, uses four sub-miniature valves. Miniature batteries, either three of 1.35 V or three of 22.5 V, provide a life of 360 and 600-800 hr. respectively. A feature of the circuit is that it permits the use of high resistance glass electrodes.



Nash & Thompson micro hardness tester for rubber

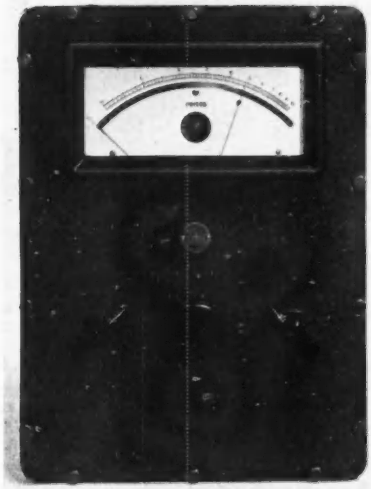
A new glass electrode for high *p*H values is being made by **Marconi**. Employing a lithium glass membrane in place of the soda/lime type, the new electrode is unresponsive to the sodium ion concentrations present in many high-*p*H solutions. Results obtained with a 0.5N NaOH solution (*p*H 13.43) show that, while errors of the order of 1.5 *p*H are

normally encountered with the usual electrode, the new lithium membrane introduces errors not greater than 0.2.

The **Dobbie-McInnes** 'Poisemeter,' now in general production after months of development work, consists essentially of an electric motor driving a drag member within the fluid whose viscosity is to be measured. Variations in viscous drag cause changes in the current flowing in the motor windings, and these changes may be indicated on a milliammeter or alternatively on a potentiometer type of recorder. The reading obtained varies roughly as the logarithm of the dynamic viscosity of the fluid, and the scale may thus be graduated directly in poises or other convenient units. It is claimed that an accuracy of ± 1.5 per cent of the indicated viscosity is obtained in all normal conditions.

Various types of drag members may be supplied, including a rotating type for use when direct access is possible from above, and a gyrating type when it is necessary to gain access through the wall of a container or pipe line below the liquid level, particularly containers under pressure.

An improved model of the **Ferranti**-Shirley cone and plate viscometer is now available. The design features include constant shear rate and shear stress throughout the fluid sample, which may have a volume of less than 0.1 ml. and a mean layer thickness of 0.001 in. The rate of shear is continuously variable over the range 0 to 25,000 sec.$^{-1}$, and stress-induced heat at high shear rates is rapidly dissipated, greatly reducing temperature rise in the liquid. Extended cylinders for measurements in deep tanks or low liquid levels and thermally-insulated cylinders for high temperature operation are available.



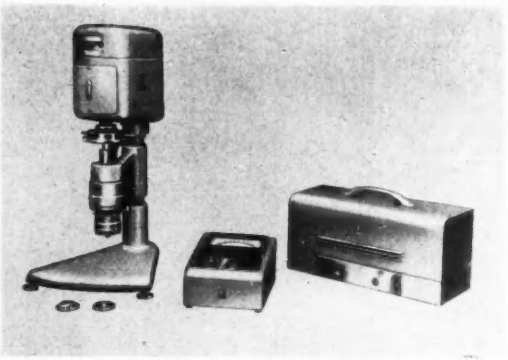
The direct-reading scale of the Dobbie-McInnes poisemeter

The Ferranti portable viscometer has been modified to allow a continuous flow of liquid through the measuring annulus.

The cost of repairing and replacing corroded buried or immersed structures is of such magnitude that an instrument designed to obtain an accurate estimate of the location and extent of corrosive action taking place should prove of great value. Such is the **Cambridge** corrosion voltmeter, designed in conjunction with Cathodic Corrosion Control Ltd.

In order to obtain absolute values of the small electric potentials involved it is necessary to avoid the introduction of any instrument that takes current from the circuit for its operation. The corrosion voltmeter incorporates a potentiometer which in effect feeds to the circuit an equal and opposite EMF to the corrosion voltage, and the measurement is made of this opposing voltage.

Pye miniature pH meter



Ferranti-Shirley cone viscometer

The Rheostatic Co. have recently introduced a number of new sizes of motorised valves, enlarging their range considerably. These valves are manufactured in a number of different types for use with steam, low pressure and high pressure hot water systems, and for various other liquids. With bodies manufactured in bronze or stainless steel, they are obtainable in straight through on/off or modulating types, as well as three-port mixing and diverting types. They are normally controlled by suitable thermostats.

An ingeniously controlled valve is that made by **James Gordon,** which employs an air-operated servomotor. Variations in operation at any distance from the valve are transmitted pneumatically to a bellows, the bellows displacement causing the motor to operate in either direction until equilibrium is restored. Movement of the valve spindle causes movement in a 'positioner'; this has a stroke of 3 in. against a cam, which in turn moves against the bellows, cutting off the motor when the valve is in the correct position. Cams can be cut to give any desired valve characteristic necessary to obtain maximum control efficiency.

Various models and sizes are available, with maximum loads from 2 to 15 tons. A 15-ton model was recently supplied for ammonia control at I.C.I.'s Billingham works.

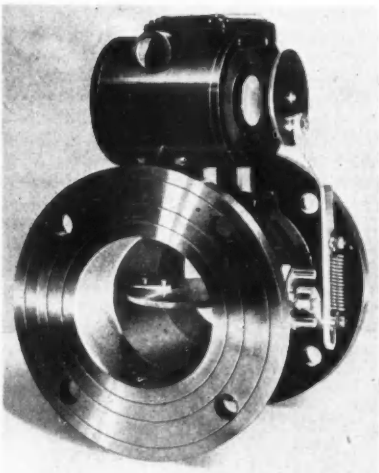
A useful innovation is the 'Flostat' (see opposite), a self-acting flow controller made by **Ultrasonics.** Fluid passing through the orifice A causes a pressure drop, which in its turn causes movement of the bellows B. The double-beat valve C is consequently moved towards the seating E and eventually the pressure drop due to the reduced flow balances the spring of the bellows. The flow rate is maintained very constant because comparatively large changes in supply or delivery pressure cause only slight movement of the valve.

The controlled value of the flow rate is determined by adjustment of the nut D when the bellows are in a relaxed position. For units where frequent changes of flow magnitude are required, the 'Flostat' may be fitted with

Cambridge corrosion voltmeter, readily transportable

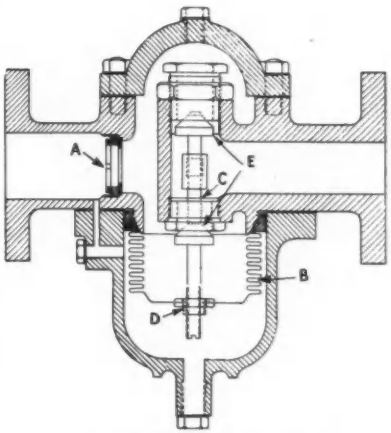
an external re-setting device. Three sizes of controller cover flow ranges from 10 to 3,000 gal. per hr., and they are available in stainless steel, phosphor bronze and mild steel.

A number of very interesting switches have been introduced during the last twelve months by **KDG.** These include a conduit switch, for pressurised electrical systems where no flameproof equipment is available ; liquid level switches ; differential pressure switches to meet stringent tightness specifications for high vacuum or high pressure ; beryllium-copper diaphragm or bourdon tube switches ; chemical switches with diaphragms which may be protected by polythene or Fluon masks ; flameproof pressure switches ; and flow switches responding to the differential pressure across an adjustable orifice, thus giving warning of blockage, etc.



View of a 4 in. 'Satchwell' motorised butterfly valve, made by the Rheostatic Co. Ltd.

The well-known Saunders valve is extensively used where gas or liquid has to be controlled ; **Edwards**, in association with Saunders, have developed a range of ' Speedivalves ' specially for high vacuum work. The new valves incorporate all the advantages of the original valve, together with new developments : there is positive closure unaffected by wear ; the mechanism is isolated from the vacuum system ; an elastomer diaphragm effectively seals the vacuum system, whether the valve is



The 'Flostat' made by Ultrasonics for fluid control

open or shut. The valves are built easily demountable and of robust construction.

As a result of the favourable reaction to a prototype instrument displayed last year at the Instrument Industries Exhibition, **George Kent** have decided to introduce their ' Microvolt Multelec ' as a standard product. This instrument accurately records potentials within a minimum full-scale range of 0-100 μV, with a source impedance of up to 50 kilohms, which represents a power sensitivity over 1,000,000 times that of conventional galvanometer instruments.

The Multelec can be used for control purposes, and where it is necessary (for safety reasons) that a break in the measuring circuit external to the instrument should result in top or bottom scale deflection, the amplifier employed can easily be set to the required result.

The application of automatic control to processes which require composite control schemes has necessitated the development of auxiliary pneumatic apparatus, and George Kent are manufacturing a range of diaphragm units to extend the operation of their Mark 20 controllers. The units are fitted into a control circuit where it is necessary to alter the magnitude of the control signal or combine two or more signals. The input and output signals are in the usual 3-15 psi. range, and the output signal from the unit is accurate to within $\pm$0.2 psi. of its theoretical value.

A close-up view of the Sifam thermocouple head

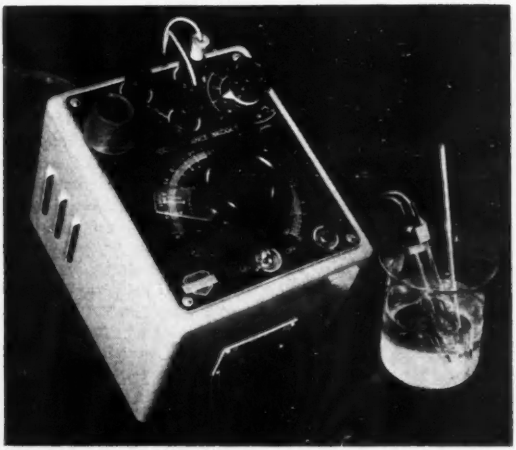
The entirely new **Sifam** thermocouple head embodies several features of interest. There is a complete absence of loose parts, fixing screws and terminal tops being captive. The insulated top plate is in a material which will withstand 400°, and the terminals are specially designed to give particularly close and positive contact, thus avoiding any parasitic EMF. Other materials and protective sheaths are available for maximum temperatures up to 1,100°.

For distant indication, recording and control of temperature, the **Negretti & Zambra** air-operated transmitter has several advantages over previous models. Working on the force balance principle, the instrument's bourdon tube has a maximum movement of 0.002 in., thus ensuring freedom from fatigue and a long, accurate life. A small sensitive bulb is employed, and no capillary is required between it and the receiving instrument. The transmitter is suitable for temperatures up to 650°, and a range as narrow as 20° is normally available.

Other advantages claimed for the instrument are that the temperature/pressure relationship is linear over the whole scale to within ±0.5 per cent ; no external booster is required on piping runs up to 200 ft. ; and the pressure output is not influenced by ambient temperature variations up to 30°.

A temperature control unit designed for the accurate control of the temperature of containers, liquids, gases, etc., is the **Airmec** unit N.856. It consists essentially of a temperature sensitive resistance element in the form of a flat winding on mica, which forms one arm of a bridge circuit. For immersion in liquids, for use in conditions of high humidity or corrosive atmosphere, or for temperatures above 250°, a sealed platinum bulb should be used. One arm of the bridge is variable, and six ranges are provided.

The bridge out-of-balance voltage is amplified and used to operate two separate relays, which are arranged to operate at slightly different temperatures, this difference being adjustable. Three conditions, ' temperature low,' ' temperature normal ' and ' temperature high ' are detected by this arrangement, and the equipment can therefore be used to control any heating or cooling process in which motor-



Mullard conductance bridge with which the new flow cell is used

controlled apparatus is used. Relays will operate and release on change of control resistance of approximately 1 per cent, which represents a temperature change of 0.3° for the mica element and 0.4° for the platinum resistance at 100°.

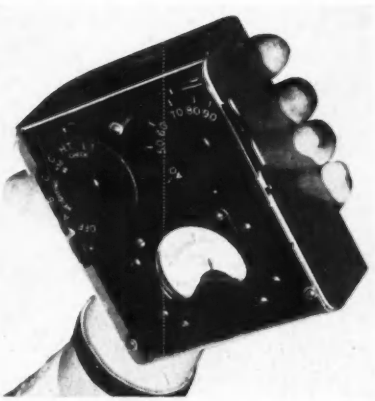
Temperature control has also been the concern of **Elliott Brothers** for some time, and one of their latest instruments is a conventional galvanometric temperature indicator with a new design of mechanical sensing device. A depressor bar causes the point to be trapped intermittently only when in the proximity of the control point setting, thus tripping a mercury tilt switch. Three switches are incorporated, giving an independent circuit to each of three differing control actions dependent only on the position of the measuring pointer.

Other important Elliott developments include a high-speed temperature indicator, particularly applicable to multi-way installations where many variables need to be logged at a central control station with the aid of a single instrument and switch; and the 'Drimac' pneumatic pressure transmitter, for the conversion of a static or differential pressure into a pneumatic output pressure for the operation of a local or remote indicator or controller.

The size 0 'Flowrators' made by **Solway** are for very low flows, ranging from 1.6 gph. of water (12 cu. ft. per hr. air) to 0.06 gph. water (0.5 cu. ft. per hr. air). Fitted with plain taper tubes, however, these are not predictable—the flow scale must be determined by flow test for each different fluid or for the same fluid at different temperatures.

But fitted with 'Tri-flat' tubes these Flowrators are fully predictable with stainless steel and ruby floats, and partly so with glass floats. Moreover, accuracy and reproducibility are good, and though the readings are affected by viscosity changes, correction curves can be applied. The principal reason for the improved performance of these tubes is that the floats are centrally guided by the three parallel flats which run the length of the conically-tapered tubes. Unguided floats readily adopt an eccentric position due to air bubbles, surface tension, etc.

Additions to the industrial range of Flowrators include Series 200 enclosed glass tube and Series 400 metal tube models, used with extension instruments for pressures up to 600 psi. for dangerous fluids such as carbon disulphide and petrol and (in the case of metal



Dawe sound level meter, small enough to be held in the hand

tubes) for steam and caustic; Series 900 specific gravity tester for continuous or intermittent measurement of liquid density and temperature; and Series 1000 'Ratosleeve' for larger flows than Series 200 or 400, but for the same dangerous substances.

Mullard have announced a new industrial flow cell for use with their conductivity controller.

An important development of the by now well-known **Dawe** ultrasonic thickness gauge is the Type 1101/1, in which the previous range of 0.06 to 12 in. wall thickness is extended down to 0.02 in. This is achieved by using higher ultrasonic frequencies in the range 2 to 6 Mc/s. This gives improved accuracy over the range 0.06 to 0.25 in., although above 0.25 in. the standard model is still recommended.

Shown in prototype at the Physical Society Exhibition was the Dawe electronic gauge. This is fundamentally an accurate length comparator. The circuit consists of a differential transformer type gauge head with a high-gain amplifier and an indicating meter. Any movement of the probe on the gauge head produces an output signal proportional to the movement.

Another Dawe instrument of use is the sound level indicator, small enough to be held in the hand. It weighs only two pounds, yet has a range of 30 to 135 db. above standard reference level of 0.0002 dynes per sq. cm. at 1000 c/s.

The increasing use of jackets containing

Complete kit for the Dawe ultrasonic thickness gauge Type 1101B

hydrogen for the cooling of large electric generators has led to a demand for suitable means to prevent the formation of explosive gas mixtures. The **Cambridge** gas analyser employs the well-known Shakespear katharometer based on the thermal conductivity of the gas, and is calibrated to 100-85 per cent hydrogen. There is also an indicator for air and hydrogen in carbon dioxide.

The 'Satchwell LER' unit, made by the **Rheostatic Co.**, is designed to signal to the control box of an oil burner when the oil is not ignited on starting up or when the flame fails during a run. It is operated by the light emitted from the flame itself, and, consequently, its response is almost immediate ; a device which relies on flue temperature is too sluggish, nor can it be applied to installations having more than one burner firing into a common flue. The device consists of two units, a photocell head, and an amplifier-relay unit.

Protection of diesel and similar engines is the concern of **Teddington Industrial Equipment**, and devices include an oil pressure failure device which closes the throttle and shuts down the engine in the event of falling oil pressure ; an engine safety switch sensitive both to lubricating oil pressure and coolant temperature, and in some models also to oil temperature ; a protection unit for diesel-powered air compressors ; and a hydrostatic priming panel which will ensure a centrifugal pump installation remaining primed under all conditions.

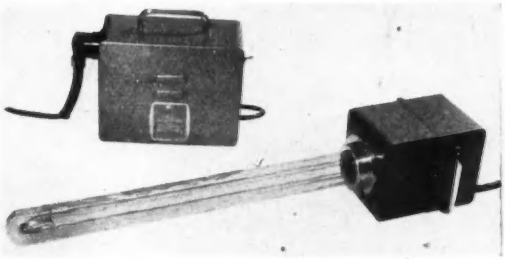
Among the many electronic instruments now appearing on the market the chemist generally feels himself rather lost, but with *p*H meters at least he is at home. **Electronic Instruments** have produced a meter designed for factory use ; it is robust and easy to operate, and when the door is closed it is impervious to dust, moisture or chemical fumes. Special dip and continuous flow electrodes are available, and the instrument is temperature compensated not only for variations in the *p*H-millivolt relationship, but also for changes in the reference and asymmetry potentials. The instrument is guaranteed to have a zero stability around 0.02 *p*H for 24 hr., and will remain within 0.1 almost indefinitely.

New items exhibited by **Labgear** at the Physical Society Exhibition included various combinations of instruments to suit different counting applications. In a new scintillation head, the interchangeability of a detachable collimator and sodium iodide crystal with a suitable phosphor coated screen renders the unit adaptable to directional gamma counting and for laboratory applications where the head can be mounted vertically above the sample holder.

For use with the head is the pulse amplifier-discriminator, and another interesting piece of apparatus is an electric tachometer.

Other counters are the type N.851 of **Airmec**,

Hanovia immersion type bactericidal UV unit

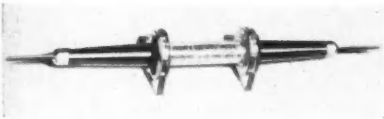


which is a general purpose instrument for rates up to 3000 per sec. ; and model 2DNR of **Davis, Wynne & Andrews**, which is capable of counting up to 5000 per sec.

Accurate checking of small electrical measurements is possible with the **Taylor** test meter 171A. The basic features of the instrument are a self-balancing double triode bridge network, and a miniature duodiode probe unit, compensated against drift. The probe allows connection to be made very close up to the circuit under test, and has a frequency response extending into the UHF region.

The AC voltmeter has six ranges : 0-1-2.5-10-25-100-250V ; the DC voltmeter has eight ranges : 0-1-2.5-10-25-100-250-1000 V, and 25 kV with optional external adapter ; resistance ranges are 0-10,000 ohms, 0-1,000,000 ohms, 0-1 megohm, 0-10 megohms, 0-100 megohms, 0-1,000 megohms ; and there are five ranges on the output meter.

An accessory for the Model 8 AvoMeter and the ' AVO ' electronic test meter made by **Automatic Coil Winders** is a new 25,000 V DC multiplier, which is believed to be the first reasonable small and safe multiplier for high voltages.



25,000 volt AVO multiplier

Three very interesting pieces of equipment employing UV light have recently been developed by **Hanovia Ltd.** Their water steriliser, described in THE CHEMICAL AGE recently (1954, **70**, 627), has been tested at the National Institute for Research in Dairying at Shinfield. It was shown that with quite high flow rates of badly contaminated water over 99.9 per cent kill could be obtained; even heat resistant spores of *B. subtilis* sustained a 99.7 per cent kill. A mobile unit has now been designed, being a powerful low pressure U-tube housed in a quartz jacket, which can be partly immersed in, for instance, a storage tank. Consumption is only 50 watts, and effective life is estimated at 2,500-3,000 hr.

Finally, cracks and leaks in condensers and welds may be traced by the use of fluorescent tracers and an intense beam of filtered UV from the Model 16 lamp or the smaller ' Detectolite.'

BUYER'S GUIDE

Airmec Laboratories Ltd., High Wycombe, Bucks. Tel.: High Wycombe 2060/4.

H. Reeve Angel & Co. Ltd., 9 Bridewell Place, London, E.C.4. Tel.: CENtral 9833.

Automatic Coil Winder & Electrical Equipment Co. Ltd., Douglas Street, London, S.W.1. Tel. : VICtoria 3404/9.

C. Baker of Holborn Ltd., 244 High Holborn, London, W.C.1. Tel.: HOLborn 1427 & 4004.

Baldwin Instrument Co. Ltd., Princes Road, Dartford, Kent. Tel.: Dartford 2980 & 2989.

Bellingham & Stanley Ltd., 71 Hornsey Rise, London, N.19. Tel.: ARChway 2270.

Cambridge Instrument Co. Ltd., 13 Grosvenor Place, London, S.W.1. Tel.: SLOane 9146.

Casella (Electronics) Ltd., 46-48 Osnaburgh Street, London, N.W.1. Tel.: EUSton 8144.

Davis, Wynn & Andrews Ltd., Vittoria House, Cheltenham. Tel.: Cheltenham 53606.

Dawe Instruments Ltd., Ealing, London, W.5. Tel.: EALing 6215/7.

Dobbie McInnes Ltd., 191-3 Broomloan Road, Glasgow, S.W.1. Tel.: GOVan 2394.

Doran Instrument Co. Ltd., Stroud, Glos. Tel.: Stroud 15 & 462.

W. Edwards & Co. (London) Ltd., Manor Royal, Crawley, Sussex. Tel.: Crawley 1500.

Electronic Instruments Ltd., Richmond, Surrey. Tel.: Richmond 5656.

Elliott Bros. (London) Ltd., Century Works, Lewisham, London, S.E.13. Tel.: TIDeway 3232.

H. J. Elliott Ltd., Treforest Trading Estate, nr. Pontypridd, Glam. Tel.: Treforest 2555.

Evans Electroselenium Ltd., Potter Street, Harlow, Essex. Tel.: Potter Street 110/111.

Everett, Edgcumbe & Co. Ltd., Colindeep Lane, London, N.W.9. Tel.: COLindale 6045.

Evershed & Vignoles Ltd., Acton Lane Works, Chiswick, London, W.4. Tel.: CHIswick 3670.

Ferranti Ltd., Hollinwood, Lancs. Tel.: Failsworth 2000.

Flatters & Garnett Ltd., 309 Oxford Road, Manchester 13. Tel.: Ardwick 3533.

James Gordon & Co. Ltd., Dalston Gardens, Stanmore, Mddx. Tel.: WORdsworth 3631.

Hanovia Ltd., Slough. Tel.: Burnham 500.

Hilger & Watts Ltd. (Hilger Division), 98 St. Pancras Way, London, N.W.1. Tel.: GULliver 5571/7.

Integra, Leeds & Northrup Ltd., 183 Broad Street, Birmingham, 15. Tel.: Midland 1453/4.

Jencons (Scientific) Ltd., Rosebank Way, London, W.3. Tel.: ACOrn 4628/9.

KDG Instruments, Purley Way, Croydon, Surrey. Tel.: THOrnton Heath 3868.

George Kent Ltd., Luton, Beds. Tel.: Luton 2440.

Labgear (Cambridge) Ltd., Willow Place, Cambridge. Tel.: Cambridge 2494/5.

Loughborough Glass Co. Ltd., Loughborough, Leics. Tel.: Loughborough 3855.

Marconi Instruments Ltd., St. Albans, Herts. Tel.: St. Albans 6161/5.

Measuring & Scientific Equipment Ltd., 14-28 Spenser Street, London, S.W.1. Tel.: VICtoria 6086.

Mullard Ltd., Shaftesbury Avenue, W.C.2. Tel.: GERrard 7777.

Nash & Thompson Ltd., Oakcroft Road, Tolworth, Surrey. Tel.: ELMbridge 5252.

Negretti & Zambra Ltd., 122 Regent Street, London, W.1. Tel.: REGent 3406.

L. Oertling Ltd., Cray Valley Road, St. Mary Cray, Orpington, Kent. Tel.: Orpington 5771.

W. G. Pye & Co. Ltd., Newmarket Road, Cambridge. Tel.: Cambridge 4032.

The Rheostatic Co. Ltd., Slough, Bucks. Tel.: Slough 23311/6.

Sifam Electrical Instruments Co. Ltd., Higher Lincombe Road, Torquay, Devon. Tel.: Torquay 4547/8.

Solway Flowrators Ltd., Abbey Road, London, N.W.10. Tel.: ELGar 7641.

Southern Instruments Ltd. (Special Products Division), Camberley, Surrey. Tel.: Camberley 2230.

Stanhope Engineering Co. Ltd., Chapter Road, London, N.W.2. Tel.: WILlesden 1142.

L. A. Steiner, 76 Cavendish Road, London, S.W.12. Tel.: TULse Hill 3579.

Taylor Electrical Instruments Ltd., 419-424 Montrose Avenue, Slough, Bucks. Tel.: Slough 21381.

Techne (Cambridge) Ltd., Duxford, Cambridge. Tel.: Sawstone 246.

Teddington Industrial Equipment Ltd., Sunbury-on-Thames, Mddx. Tel.: Sunbury-on-Thames 600.

C. Tennant, Sons & Co. Ltd., 4 Copthall Avenue, London, E.C.2. Tel.: MONarch 7741.

J. W. Towers & Co. Ltd., Victoria House, Widnes, Lancs. Tel.: Widnes 2201.

Townson & Mercer Ltd., Beddington Lane, Croydon, Surrey. Tel.: THOrnton Heath 6262.

Ultrasonics Ltd., Otley, Yorks. Tel.: Otley 3103

Unicam Instruments Ltd., Arbury Road, Cambridge. Tel.: Cambridge 55227.

Daniel Varney Ltd., Netherton Road, Wishaw, Lanarkshire. Tel.: Wishaw 142/5.

New Potentiometer

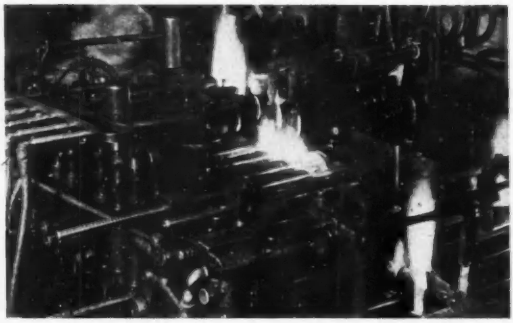
NEWEST instrument announced by the Croydon Precision Instrument Co., 116 Windmill Road, Croydon, is the self-contained DC potentiometer Type P3. This is a medium grade instrument, suitable for general laboratory use such as calibration of instruments, measurement of resistance, voltage and current, calibration of wattmeters, thermocouple measurements, photoelectric measurements, etc.; there is a built-in sensitive reflection galvanometer, a standard cell and a supply battery, and the potentiometer has an independent standardising circuit. The instrument has three range multipliers: x1-1.9 V to 1 mV subdivided to 0.5 mV; x0.1-0.19 V to 100 μV, subdivided to 50 μV; and x0.1-0.019 V to 10 μV, subdivided to 5 μV.

Glass & Chemistry

An Important Partnership

IT is thirty years since James A. Jobling & Co. Ltd. first introduced 'Pyrex' laboratory ware to this country, and there is no doubt that this was an event of supreme importance to chemistry. The resistance to heat and chemicals which is characteristic of Pyrex has made possible many syntheses and analytical operations which were formerly difficult, and its uniform qualities have made the fabrication of complicated glass apparatus much simpler.

Joblings on Wearside are, since the withdrawal of Chance Bros. from the field, unquestionably the largest glassworks outside the US for scientific glassware.



Above: a skilled lampworker making a piece of specialised apparatus; left: a test tube machine; and below: a glass-blower at the furnace moulding a boiling flask

Beakers and flasks ranging in capacity from 5 ml. to 100 l. are regularly manufactured, together with giant bulbs for mercury arc rectifiers. Glass tubing of diameter from 3 mm. to 10 cm., with walls of many different thicknesses, is drawn automatically from tanks containing more than 100 tons of molten glass.

Precision work is an essential part of Pyrex production; extrusion tubing is produced on mandrels with bore-dimensions accurate to ± 0.01 mm., for the manufacture of hypodermic syringes and accurate burettes and pipettes, and accurate shaping and grinding is necessary in the production of 'Grip-Seal' interchangeable joints.

Among the many specialised pieces of apparatus fabricated in Pyrex, one of the most impressive is the Oldershaw 20-plate fractionating column, used in oil refining. Each plate in the column is two inches in diameter and has 300 holes drilled to fine precision limits.

Saskatchewan's Potash

Deposit Third Largest in World

REPORTING that Saskatchewan's potash deposit was third largest in the world, Dr. J. O. G. Sanderson, consulting geologist and president of the Western Potash Corporation, stated that in 1953 potash was first noted in wells drilled in Saskatchewan by the Norcanol Company.

In 1946, Bata Petroleum drilled an oil and gas test well near Unity, Saskatchewan, hoping to get full information on the Elk Point salt bed in order that salt protection could be established at Unity and an industrial use found for the gas and oil drilled in that locality. At a depth of 3,445 feet, the top of a 450-foot salt bed was found topped by 25 feet of blood-red to pink coloured salt. Analysis proved this to be sylvinite ore which gives potash. The Saskatchewan deposit was the third one of major proportions found so far on the face of the earth.

For many years, Germany, to whose scientists goes the credit for discovering the use of mineral potash for fertiliser, had a virtual world monopoly on this product. Some indication of the importance of the product could be seen in the fact that 8,750,000 tons of the ores of potash were mined in the United States in 1953, said Dr. Sanderson. He added that potash was perhaps the only known mineral substance which would continually refresh and revitalise worn out soils and cause them to nourish plant crops repeatedly. It had other uses to a more limited extent in the chemical industry in glass manufacture, soap, explosives, etc.

The importance and value of potash in abundance to Canada could not be overestimated said Dr. Sanderson. Canada had a tilled area of 174,000,000 acres. This area grew larger each year and had good prospects for a continued productive future because of the presence in Saskatchewan of this mineral fertiliser in a quantity which should last 1,000 years.

Latest official report from Western Potash indicated shaft down to 320 feet horizon after encountering formidable quicksands. Normal shaft sinking operations are underway to depth objective of 3,500 feet.

Telephone Number Change

Sunvic Controls Ltd. have changed the telephone number of their Harlow works to Harlow 24231/5.

Monsanto's New Plant

CONSTRUCTION of a major plant to manufacture maleic anhydride by direct oxidation of benzene is shortly to begin by Monsanto Chemicals Ltd., at their Ruabon, North Wales, factory. Hitherto, the company have obtained it as a by-product.

The new installation will be built specifically for the production of maleic anhydride, and its output, it is stated, should be sufficient to cater for all the known needs of industry in Great Britain. The design will permit rapid expansion to meet any future growth of demand.

The new plant is part of the continuous programme of expansion which has been carried out at this location since the war, and on which approximately £5,000,000 has already been spent.

Maleic anhydride is a basic industrial chemical which is used as a raw material for the manufacture of alkyd and polyester resins employed in the paint and plastics industries, and as a starting-point for various important organic syntheses.

OEEC Mission to US

TREATMENT of air pollution has been considerably developed in the US in recent years, and a mission consisting of 11 members representing seven OEEC member countries left on 16 June for a six-week tour of the US to study this question.

While not intending to examine the treatment of water pollution as such, the mission, it is stated, will nevertheless study the relevant inter-state and international regulations in force in North America.

The mission has been planned under the OEEC technical assistance programme as a follow-up to that which visited six European countries to study the treatment of air and water pollution, but which concentrated mainly on the latter subject.

Order for Dry Gas Holders

Ashmore, Benson, Pease and Co. Ltd., of Stockton, have received an order from Dorman Long and Co. Ltd., to build two large Klonne-type gas holders at their Cleveland works. Capacity of the holders will be 5,000,000 and 3,000,000 cu. ft.; the larger one will be 257 feet high. Construction of the gas holders will begin this year.

Sulphuric Acid Plant Extension Plan

Bradford Firm Appeals Against Corporation's Objection

PROPOSED extension to the plant of Leathers Chemical Co. Ltd., Canal Road, Bradford, said to be the oldest sulphuric acid plant in the country, was the subject of a public inquiry at Bradford Town Hall, on 9 June. The firm were appealing against the conditions imposed by Bradford Corporation when granting the firm's application to build this third unit to the existing plant.

Mr. Stanley Price, on behalf of the firm, explained that last year the Corporation gave town planning permission to the company to erect new plant, including an acid chamber, Glover tower concentrator and furnaces on vacant land adjoining their works on the east side of Wharf Street, Bradford, but imposed conditions which were objected to by the company as uneconomical.

Mr. Price pointed out that one of the aims of the Corporation was to lessen, as far as possible, the emission of noxious gases and they also stressed the desirability of such industries being in the area set aside in the new development plan. The company claimed that the new expansion would help to reduce the objectionable emissions. The new extension would cost £35,000, it was estimated, but the Corporation sought to limit its life to 15 years which would make it uneconomical. A further condition to which objection was taken was that the Medical Officer of Health or other officials should have the right of entry to the works in order to take samples of air.

Removal Discussed

The Corporation, in representations to the Ministry, said Mr. Price, had referred to the nearness of housing sites on which it was proposed to build flats. Discussions had taken place about the possibility of transferring the undertaking to Wyke, on the outskirts of Bradford.

Mr. J. R. Burnett, managing director of the firm, confirmed that the idea of the ultimate removal of the works to Wyke was an excellent one in principle, but it would cost £600,000 to £700,000.

Mr. S. G. Wardley, Bradford City Engineer, stated that the company had been informed in 1950 that the Corporation would like to see the works transferred and that it would not view any extension of the works favourably. The company, he said, agreed that such a transfer was desirable, and he argued that if the firm was sincere, then a period of 15 years to effect the removal was reasonable.

Profitable Proposition

When asked by Mr. Price, who was to put up the £600,000, Mr. Wardley replied that it should be a profitable proposition if the production was so essential to the nation's industries. He added that the Corporation was prepared to help in the provision of a site and to make a contribution to the cost of roads and drains. The Corporation hoped that the firm would see its way to transfer the works to a site at Low Moor or Wyke, in an area scheduled for noxious industries, as planned in the city's development scheme.

Mr. Price, in a final address, declared that if the Corporation cared to put down the money the works could be moved at once, but he alleged that it was because they wanted to avoid paying a proper compensation that the conditions objected to had been set down to the permission for the extension.

Declaring the inquiry closed, Mr. A. C. Todd, Inspector of the Minister of Housing and Local Government, who had conducted the inquiry, intimated that he intended visiting the works. Mr. C. Bride, District Inspector of Alkali, also attended the inquiry.

In the course of the inquiry it was stated that this sulphuric acid plant of Leathers Chemical Co. Ltd. was established on its present site near the centre of Bradford in 1750. It now produced 450 tons of sulphuric acid a week, and in order to maintain this level of production the extension was required to enable two of three plant units to be operated while the third was being repaired. Regarding the condition that the Medical Officer of Health should have power of entry, Mr. Price said: 'We do not want the Medical Officer, or any other Corporation official, wandering about inside our works.'

Laporte Industries' Profits

New High Levels for Almost Every Product

VOLUME of business transacted by the Laporte Industries group for the year ended 31 March, 1954, attained new high levels for almost every product manufactured by each of the operating companies, states Mr. L. P. O'Brien, chairman, in a statement accompanying the annual accounts.

Untaxed group income expanded from £529,681 to £1,037,839, and it is the first time the million mark has been exceeded.

The high level of demand continued during the first two months of the current financial year and the stock position of buyers, adds Mr. O'Brien, seems to be maintained at reasonable levels compared with abnormal stocks held two years ago.

Proposed New Issue

Net profit of the group is doubled at £623,188, compared with £306,784, and the reserve allocation is at £200,000. The dividend is raised from 12½ per cent to 16 per cent and is payable on more capital. The 5 per cent interim dividend was paid on £1,486,950 ordinary stock and the proposed final is on £1,492,150. For the previous 12 months a 2¾ per cent interim dividend was paid on £1,479,950 and the 9¾ per cent final on £1,486,950. A one-for-three scrip issue to stockholders registered on 1 July is also proposed.

Notes on the accounts recall that as from 1 April, 1953, Laporte Industries Ltd. became a holding company only and transferred its manufacturing business and assets to Laporte Chemicals Ltd., a new subsidiary operating company formed for that purpose. During the year the name of National Titanium Pigments Ltd. was changed to Laporte Titanium Ltd., and that of the Australian subsidiary from Crystal Laporte Proprietary Ltd. to Laporte Chemicals (Australia) Proprietary Ltd. Contracts placed for capital expenditure of the parent company amounted to £37,500 and of the subsidiary companies to approximately £410,000 making a total for the group of £447,500, compared with £915,000 in 1953.

The chairman's statement says that in February, 1954, the company purchased for £12,000, plus the issue of 20,800 Laporte ordinary shares of 5s. each, the total issued and fully paid shares in A. W. Brook Ltd., of Leicester, consisting of 3,000 7½ per cent cumulative preference shares of £1 each and 6,100 ordinary shares of £1 each.

Laporte Acids Ltd. was the new name resulting from the merger of two old companies—Hunt's of Castleford, and Nicholson's of Hunslet. This company made principally sulphuric and hydrochloric acids for sale, and contributed to group surplus substantially last year. The new acid plant came into production smoothly in January. Meanwhile, the company's older plants, accounting for over 50 per cent of Laporte Acids Ltd. total sulphuric acid output, were in a good state of repair and operating at full production. On the other hand it was proposed to close down their Monk Bretton works and transfer to Castleford the manufacture of industrial detergents carried on there. Apart from the transfer of the detergents department and the erection of a new administrative centre, no immediate large scale capital expenditure was contemplated at either of the Yorkshire plants.

Plant Extensions

Further building and plant extensions for Laporte Chemicals Ltd., at both Luton and Warrington were in progress, as this subsidiary could not yet meet all the demands for quite a number of the chemicals manufactured by it.

They were using less and less barium oxide every year for the manufacture of hydrogen peroxide. They were now operating a works scale experimental plant using a cyclic process based on the successive reduction and oxidation of an organic compound.

The titanium oxide plant opened at Luton in 1933 and operated by Laporte Titanium Ltd. continued to operate at full capacity, while at Stallingborough, North Lincolnshire, they were now engaged in duplicating plant to meet the unsatisfied world demand for this product.

All the shares of Laporte Chemicals (Australia) Proprietary Ltd. were now held by the parent company, who had subscribed new capital amounting to £A60,000 to enable this subsidiary to extend its plants at Botany.

Fatty Acids Centenary

First Hundred Years at Bromborough

IN 1830, in Vauxhall, E. Price & Co. began the production of candles. These were no longer the soft, smoky, dim tallow candles, but were made of hard stearine after the separation of liquid oleine. Price's soon discovered that the yield of hard fatty acids could be increased by heating oils with sulphuric acid, and their problem then was to improve the colour of their product. Vacuum distillation was found to be possible but not practicable, and finally, in 1842, a steam distillation process was patented.

After contacts made at the Great Exhibition of 1851, the French adopted Price's patent for the steam distillation of oleine, obtaining a purer product, while Price's obtained the rights in the use of oleine for lubrication in wool spinning.

The result of these developments was that in 1854 a site of 60 acres was purchased, five miles south of Birkenhead, on the banks of Bromborough Pool: Price's (Bromborough) Ltd., destined 100 years later to be the largest factory of its kind in Great Britain, was born.

It was in the same year that the steam distillation of glycerine was developed, thus making available a purified product which until then had been thrown away as waste. Since then, the interests of the Bromborough factory have been concerned more and more with the production of separated and purified substances, and in 1937 they joined the Unilever Group, severing all connection with Price's Patent Candle Co. Ltd., which still flourishes in Battersea.

During the last 15 years, Bromborough has taken up the manufacture of fatty alcohols, including the sperm oil alcohols, acquired rights for the Emersol solvent extraction process, introduced continuous-production vacuum stills and begun work in molecular distillation.

Price's (Bromborough) Ltd. today supply over 200 products to 40 different countries, where they are used to make flavouring essences and perfumes, engineering greases and cutting oils, industrial and household soaps and other detergents, horticultural sprays, printing inks, typewriter ribbons and carbons, the plastic basis for sound recording, and many other essential or luxury articles.

Last year the company sent goods valued at $150,000 in direct exports to the dollar-countries, and it has been estimated that 70 per cent of the factory's output forms the raw material for exported goods.

A commemorative book, published last week by the company in celebration of its centenary, describes and illustrates the many processes and products which have come from Price's of Bromborough in the years 1854-1954.

Seaweed Research Institute

Laboratories and workshops of the Institute of Seaweed Research, Inveresk, were open to inspection by visitors on 18 June. Since last year's open day, there has been an appreciable increase in the output of the British seaweed utilisation industry which has been working to capacity in the production of alginates, fertilisers and animal foodstuffs.

The pathology laboratories of the Hope Hospital, Salford, furnished by Cygnet Joinery Ltd. Architects were Harry S. Fairhurst & Son, F.A.R.I.B.A.

I.C.I. Widening Its Range

Wilton Pivot of New Development

LATEST developments in the production of organic chemicals by I.C.I. at Billingham and Wilton are discussed by Mr. E. Beesley, organics technical manager, Billingham, in an article in the June issue of the *Tees-side Journal of Commerce.*

Closely associated with the new range of plastics and fibres represented by polythene, nylon and Terylene, all of which were, or shortly would be, produced on a very large scale in the Billingham and Wilton plants, says Mr. Beesley, were a number of other interesting chemicals, not so well known to the general public.

Pivotal plant of this new industrial exploit was the Wilton cracker. The gases from this plant were used in the so-called petroleum-chemical processes operated at Billingham and Wilton. They were used directly in polythene and indirectly in Terylene, but an equally important usage lay in this new range of organic products which were essential raw materials in the production of finished plastic products, resins, paints, lacquers, solvents, lubricant additives, petrol additives, disinfectants, fungicides, preservatives, dyes and pharmaceuticals.

'To name some of these chemicals,' Mr. Beesley adds, 'we have, first, the series known as carbonylation products; these are *iso-* and *n*-butanols, nonanol and Alphanol.

'Another series of chemicals is derived from tar acids which are either made synthetically, like phenol, or extracted from creosote, which is used for the manufacture of petrol by hydrogenation—a Billingham achievement of the 30's. These chemicals are octyl phenol, octyl cresol, Topanol A, Topanol O, *para*phenyl phenol and *ortho*-phenyl phenol. The plants in which they are made are new and the processes have been worked out at Billingham. Other big plants operate on *iso*-propanol and acetone production, again by novel Billingham processes replacing classical methods.'

Principles for Plastics

SOME 486 companies identified with the plastics industry in the US are now subscribing to the recently announced Statement of Principles of the Plastics Industry, which was prepared by executives of industry companies. In a statement making the announcement, Mr. C. B. Branch, of the Dow Chemical Co., and chairman of the Plastics Group of Manufacturing Chemists' Association Inc., says the Statement of Principles has been considered by industry executives to be desirable in view of the phenomenal increase in applications and new uses of plastics materials. These products, they say, present a continuing challenge to manufacturers and processors to apply materials in a manner that will best serve the interests of the public and industry. The Statement enumerates four basic concepts designed to bring to the industry and public alike all benefits, economies and satisfactions inherent in these engineering and construction materials. Of the signatories to date, 34 are members of the Manufacturing Chemists' Association Inc., and 452 are members of the Society of the Plastics Industry Inc., and include firms in Canada, England, Germany, France, Brazil and Switzerland.

Petroleum Products

DELIVERIES of petroleum products into consumption in the first quarter of this year totalled 5,087,821 tons, 416,915 tons more than in the same period of 1953, according to statistics published by the Petroleum Information Bureau on behalf of the UK Petroleum Industry Advisory Committee. This figure does not include deliveries for bunkers for ships engaged in foreign trade.

Deliveries of motor spirit (including motor benzole) were 1,271,746 tons (against 1,275,389 tons), industrial spirits (including industrial benzole) 29,009 tons (22,301 tons); kerosene, 383,305 tons (against 424,980 tons); paraffin wax and scale, 10,484 tons (8,523 tons); propane and butane, 14,204 tons (12,738 tons); bitumen, 169,474 tons (157,411 tons); other products, 420,690 tons (368,401 tons).

New Swedish Development

A new method of segregating and analysing large molecules, which is especially suitable for the observation of protein molecules, virus, etc., has been developed by Professor Arne Tiselius, of Uppsala.

Expected to become of great importance for medical, biochemical and atomic research the method is described as an extension of the previously known chromatographic and electrophoresis methods.

HOME

Industrial Instruments to be Exhibited

A representative range of electronic industrial control units made by Elcontrol Ltd., 10 Wyndham Place, London, W.1, will be exhibited at the Manchester Electronics Exhibition, arranged by the Institution of Electronics (North West Section) at the Manchester College of Technology from 14 to 20 July.

Thermometer Tubing Plant

A 130 ft. tube-drawing tower for production of clinical thermometer tubing has been installed at the Wealdstone glassworks of James Powell & Sons (Whitefriars) Ltd., at a cost of approximately £12,000.

Work Study & Efficiency Pamphlet

Six articles by senior executives of Imperial Chemical Industries Ltd. recently published in *The Financial Times*, under the heading, 'Management, Work Study and Efficiency,' have been produced in the form of a pamphlet. Copies can be obtained from the Publisher, *The Financial Times*, 72 Coleman Street, London, E.C.2, price 1s.

Vacuum Oil Company's Ownership

Chairman of Powell Duffryn, Sir Herbert Merrett, has stated that negotiations are in progress with Socony-Vacuum, of New York, which may affect the nature of the Powell Duffryn holding in the Vacuum Oil Company, which operates the Coryton Refinery. Powell Duffryn own directly and through their subsidiary, Cory Brothers & Co. Ltd., 50 per cent of the capital of Vacuum Oil Co. The remaining 50 per cent of the capital is owned by Socony-Vacuum.

Atomic Power Station

By mid-1956 the Sellafield atomic power station should be ready for running-up and testing. After another few months the first atomic power station should be supplying electricity to the arterial network of Britain. This forecast was made by Sir George Nelson, chairman and managing director of the English Electric Co. Ltd., in a paper on 'Electrical Engineering in World Trade' at the British Electrical Power Convention at Eastbourne on 15 June Owing to Sir George's absence abroad on business his paper was read by Mr. H. G. Nelson, deputy managing director of the company.

Acetone Price Reduction

Reduction in price by £7 per ton of Bisol acetone and Shell acetone, with effect from 18 June, is announced by British Industrial Solvents and Shell Chemicals Ltd., respectively The new price schedule (in £ per ton, carriage paid) is as follows: In small lots, 5-gal. drums, £129; 10-gal. drums, £119; in 40/45-gal. drums, less than 1 ton, £94; 1-10 tons, £91; 10-50 tons, £89; 50 tons and over, £88. For the 5- and 10-gal. lots the packages are included; for the larger lots the packages are returnable at the seller's expense. Bulk delivery allowances remain unchanged.

Galvanisers' Oxford Conference

Latest advances in galvanising science, methods and costing will be discussed by delegates representing leading metal firms in Britain, the US, France, Germany, Turkey and Greece, at the Third International Conference on Hot Dip Galvanising, at Oxford from 4 to 7 July. Some 250 scientists and their wives will be attending. Half will be housed in the colleges and dine in the Hall, and half in hotels. The technical sessions will be held in the Union.

Aslib Annual Conference

Delegates representing industry, commerce, research and intelligence work, from all parts of the world, will attend the annual conference of the Association of Special Libraries and Information Bureaux—Aslib—to be held at the Church House, Westminster, from 24 to 27 September.

Stabilisation of Sub-bases

In our issue of 13 March on page 636 under the heading 'New Registrations' we gave particulars of a private company, Sterilisation of Soils Ltd. The facts given were correct but the name of the company should have been Stabilisation of Soils Ltd. The head office of the company is 42/43 Denmark Street, High Wycombe, Bucks., but there are also offices at Scunthorpe and Manchester. The firm is concerned with the stabilisation of sub-bases for roads and hard standings. Although it was no fault of our own we regret any inconvenience which might have been caused by the publishing of this misinformation.

OVERSEAS

Rising Middle East Oil

Production of crude oil in the Middle East countries rose from less than 98,000,000 tons in 1951 to nearly 122,000,000 tons in 1953—representing an increase from 16.5 per cent of the world production to 18.4 per cent. Among the eight producing countries—Bahrein, Egypt, Persia, Iraq, Kuwait, Qatar, Saudi Arabia and Turkey—production increased most in Iraq and Kuwait.

Uranium Mill to Increase Output

Eldorado Mining Co. is planning a 40 per cent increase to its Ace mine mill at Beaver Lodge to 700 tons daily to allow the handling of Customs uranium ore, states a message from Ottawa. The present 500-ton mill is treating only ore from the company's own mine. Ore now being shipped under contract from Rix-Athabasca Uranium Mines is being stockpiled pending completion of the expansion, which should be available in the late summer.

British-owned Firm Producing Zinc Oxide

Zinc oxide is now being produced at Milton, Ontario, by a new British-owned enterprise, Canadian Felling Zinc Oxide Ltd., a subsidiary of A. G. Turnery Engineering Co., owners of the Felling Zinc Oxide Co., of Gateshead, England. The company formerly shipped considerable quantities of zinc oxide to Canada. Investment of $150,000 British capital has been made in the new plant, on an 8½ acre site. The Pigment & Chemical Co., of Toronto, which represented the British firm in Canada, will handle sales.

Doubling Ammonia Production Plant

Because of the exceptionally firm market for ammonia in the mid- and north-west US, there is a possibility that Sherritt Gordon Mines might soon double the capacity of their ammonia plant at their new Fort Saskatchewan, Alta, operations. The plant, which is a major unit in the company's combined chemical-metallurgical operations, came on stream early in May, and is now operating at capacity of 75 tons a day with the bulk of output moving under contract to a Minnesota fertiliser firm for use in anhydrous ammonia form for direct application to the soil.

Great Demand for Norwegian Fertiliser

Total value of exports of nitrogen fertiliser by Norsk Hydroelektrisk Kvaelstofaktieselskab during 1953 was Kr. 300,000,000, Kr. 38,000,000 more than during 1952. Nevertheless, demand has risen so sharply that the company was unable to satisfy all orders received, and it has been decided to increase annual production of nitrate of lime by 220,000 tons.

Synthetic Fibres Catching Up

According to a report from the headquarters of FAO in Rome, synthetic textile fibres are steadily increasing competition with natural fibres in price. Since the end of the war, cotton prices in the US have averaged about 300 per cent of prewar prices, and have been rising sharply since last December. Rayon prices, on the other hand, have never risen by more than 30 per cent on prewar prices, and were reduced by about 10 per cent last year. Nylon has shown even more considerable reduction. FAO report a small decline in world prices for wool and for silk during the first quarter of this year.

New Toronto Plant

Larger and more efficient facilities for the production of cleaners, insecticides, waxes and specialised industrial soaps are provided by a new plant now being constructed in Toronto by the Associated Chemical Co. of Canada. A one-acre site is available for future expansion.

South Africa's Paint Industry

South Africa's paint manufacturing industry, with an output of nearly £7,500,000 a year, was bound to feel competition when import control was removed, stated the Board of Trade and Industries in a report tabled in the House of Assembly in May. The Board, therefore, did not recommend that the present protective duties of up to 25 per cent should be reduced.

Oil-From-Coal Plant Progress

The managing director of the oil-from-coal plant at Sasolburg, in the Orange Free State, South Africa, has stated that the boiler fires would be lit for the first time in June or July, and the plant would be in full operation in about December, 1955.

PERSONAL

Appointment of three new directors—MR. GEORGE WATSON, MR. JOHN BOWDEN and MR. FREDERICK BOWRING—is announced by the Crookes Laboratories Ltd. Mr. Watson, who has been general manager since 1950, joined the company as an office boy in 1920 and graduated through all the departments of the business, successively becoming works manager, senior purchasing officer and then general manager. During the last war, in which he was awarded the M.B.E., he rose from the ranks to be a lieut.-col., serving in the Middle East and with the Allied Forces headquarters in Italy. Mr. Bowden joined the company in 1945 as sales manager, and was appointed general sales manager in 1949. He began his career as an apprentice with the retail side of Boots Pure Drug Co. Ltd., whom he later represented in Italy. He subsequently joined the Merck organisation in Darmstadt, Germany, and for a period was London representative of the Swiss firm, Hoffman la Roche. Mr. Bowring, who is already a director of C. T. Bowring & Co. Ltd., has, through his company had a close association with Crookes Laboratories for over 20 years, especially in research and production of vitamin containing oils and vitamin D_3.

Elliott Brothers (London) Ltd., announce the appointment of MR. E. B. SCHOFIELD as area sales engineer for Lancashire, Cheshire and the West Riding of Yorkshire. Mr. Schofield will specialise in the electrical measuring instrument side of the company's business and will operate from their Manchester office—66 Deansgate, Manchester 3. Telephone No. Blackfriars 7752.

MR. A. J. HOLDEN, B.Sc. (Hons. Lond.), F.R.I.C., manager of the Association of British Chemical Manufacturers, has been elected one of the first two honorary members of the Institution of Industrial Safety officers, in recognition of his services to safety in the chemical industry during the past 25 years.

DR. R. S. NYHOLM, Associate Professor of Inorganic Chemistry at New South Wales University of Technology, has been appointed to the chair of chemistry tenable at University College, London.

At a meeting of the Council of Leeds University on 16 June, DR. B. E. DOUGLAS was appointed Brotherton lecturer in the Department of Inorganic and Structural Chemistry, and DR. H. TAUBE was appointed Brotherton research lecturer in physical chemistry.

The Ministry of Supply announce that DR. C. H. JOHNSON, chief superintendent of the explosives research and development establishment, Waltham Abbey, has been appointed to succeed MR. C. S. BRYANT as director of materials and explosives research and development, with effect from 1 July. Mr. Bryant is retiring from the public service on 30 June. MR. L. T. D. WILLIAMS has been appointed to succeed Dr. Johnson as chief superintendent of the explosives research and development establishment.

MR. C. E. HOLLIS, B.Sc., F.R.I.C., has been transferred to the central personnel department of the Distillers Co. Ltd., as staff manager (industrial group). Mr. Hollis was previously manager of the plastics division at the company's research and development department, Epsom.

DR. FELIX SINGER, the well-known ceramic consultant and author, who returned from Yugoslavia in April, where at the request of UNESCO he had acted as adviser for several months on the development and application of research relating to clay and silicates at the University of Belgrade, is returning to Yugoslavia in July to carry out a technical mission on behalf of UNTAA, during which he will be at the disposal of the Yugoslav Government and help them develop certain ceramic industries. He is expected to be away for three or four months.

MR. WESLEY C. HAWKINS has been appointed sales supervisor of the new converting division of Canadian Resins & Chemicals Ltd. Mr. Hawkins, a sales representative with the company's consumer division since 1945, has taken over his new duties preparatory to the opening in July of the printing and embossing plant built by the company at Ste. Therese, Que.

Publications & Announcements

THE General Chemical & Pharmaceutical Co. Ltd. have issued a new edition of their catalogue of Judex and Judactan analytical reagents and laboratory chemicals. This contains many new entries, including additions to the already wide range of Judactan analytical reagents with 'Actual Batch Analysis.' Approved nomenclature is used throughout the catalogue, but cross-indexing is given to the familiar names which have not yet gone out of fashion. A number of analytical reagents are now shown with limits of impurity printed on the labels, and new labels of distinctive colours are also being introduced to indicate the different grades of chemicals supplied. The company will gladly send copies of the catalogue on request.

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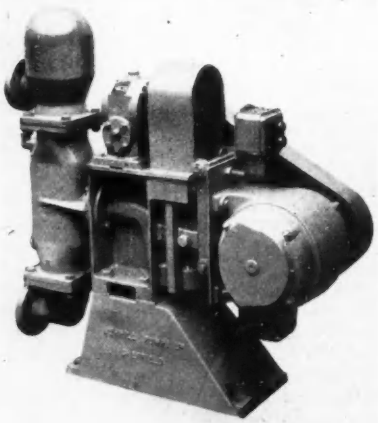
SHOWN at the Canadian International Trade Fair in Toronto this month were Merrill glandless self-priming pumps, made by Merrill Pumps Ltd., Heeley, Sheffield 8. These are tube diaphragm pumps, the tube being made of rubber, neoprene, etc., and suitable for handling acids, alkalis, dye liquors, formaldehyde, even hydrofluoric acid. Corrosion and wear affect only the tube diaphragm unit: only maintenance required is periodical refacing of valves and seatings, and ultimate replacement of the flexible tube.



TEN of the forty-nine articles in the Annual Review of British Industry, published at 1s. by *The Financial Times* this week, relate either to chemical engineering or industrial chemistry subjects. 'Stability in the Chemical Industry' is dealt with by Mr. W. J. Worboys, chairman of the Association of British Chemical Manufacturers, while Mr. G. N. Critchley discusses 'The Search for More Efficient Power.' Dr. W. P. Grove, manager of the Radiochemical Centre, Amersham, writes on 'By-Products of Atomic Energy,' and Professor F. E. Simon, Professor of Thermodynamics in the University of Oxford, reviews 'The Shortage of Scientific Manpower.' Other articles include: 'Coal; The Precarious Balance,' by Mr. S. W. Parkinson; 'Demand for Steel,' by Mr. Aubrey Jones, M.P., Economic Director, British Iron and Steel Federation; 'High Productivity in the Cement Industry' by Mr. A. W. Todd; and 'The Major Markets for Plastics' by Mr. Philip Morgan, editor of *British Plastics*. Special correspondents, who are unnamed, write about 'New Oil Refineries—New Patterns of Demand' and 'Rayon Staple Leads the Man-made Fibres.' The publication, which is well-illustrated, consists of 100 pages.

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A RECENT issue of 'Scop,' news sheet of Styrene Co-Polymers Ltd., carried a special one-leaf insert, litho-printed with an ink based on Scopol 41, a new styrenated alkyd resin. This medium, it is claimed, gives a rapid set-up with none of the disadvantages associated with quick-setting media. Copies of the issue can be obtained on request from Styrene Co-Polymers Ltd., 1 Roebuck Lane, Sale, Manchester.

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CHOICE of suitable grades of hard metal for tipping rock drills, choice of steel for the stems and problems of brazing the tip to the steel stem are among subjects discussed by Dr. E. J. Sandford and Mr. J. R. Wiles in the second of a series of articles on 'Rock Drilling with Hard Metals' in the June issue of *Alloy Metals Review*, published by High Speed Steel Alloys Ltd., of Widnes, Lancs. In a concluding article on the subject, to be published in the September issue, the authors are to consider manufacturing procedure and application.

British Chemical Prices

LONDON.—Active markets are again reported from the industrial chemicals centres during the past week, and deliveries against contracts have covered good quantities. Chemicals for the plastics industry have been in good call, and the chrome products are firm on a persistent demand. A reduction in the price of acetone by £7 per ton became effective on 18 June, and lower prices for red lead and litharge, and also for white lead, came into operation on 17 June. In the coal tar products market *meta*-cresols are in short supply and the home demand for most other items in this market remains good.

MANCHESTER.—Prices on the Manchester chemical market during the past week have been steady pretty well throughout the range, the outstanding exception being the cut in acetone. Most of the leading 'heavies' have been taken up against contracts in good quantities, especially by the textile and allied trades, though the beginning of the annual holiday stoppages in the Lancashire cotton towns has left its mark on consumption and this is likely to continue over the next couple of months or so. Trade in most types of fertilisers is at a seasonally low level. In the by-products a generally steady demand has been reported during the past few days.

GLASGOW.—There was no slackening off in demand during the past week and all sections of the industry report that business has been extremely brisk. The decrease in the price of acetone is welcomed, although prices generally have been firm, with the exception of some of the metallic salts, which have been actually varying from day to day. It has been reported that there has been a falling off in the inquiries from the export market.

General Chemicals

Acetic Acid.—Per ton : 80% technical, 10 tons, £86. 80% pure, 10 tons, £92 ; commercial glacial 10 tons, £94 ; delivered buyers' premises in returnable barrels ; in glass carboys, £7 ; demijohns, £11 extra.

Acetic Anhydride.—Ton lots d/d, £130 per ton.

Alum.—Ground, about £23 per ton, f.o.r. MANCHESTER : Ground, £25.

Aluminium Sulphate.—Ex works, £14 15s. per ton d/d. MANCHESTER : £14 10s. to £17 15s.

Ammonia, Anhydrous.—1s. 9d. to 2s. 3d. per lb.

Ammonium Bicarbonate.—2 cwt. non-returnable drums ; 1 ton lots £58 per ton.

Ammonium Chloride. — Grey galvanising, £31 5s. per ton, in casks, ex wharf. Fine white 98%, £25 to £27 per ton. See also Salammoniac.

Ammonium Nitrate.—D/d, £34 10s. per ton.

Ammonium Persulphate. — MANCHESTER : £6 5s. per cwt. d/d.

Ammonium Phosphate.—Mono- and di-, ton lots, d/d, £97 and £94 10s. per ton.

Antimony Sulphide.—Golden, d/d in 5-cwt. lots as to grade, etc., 2s. 2d. to 2s. 8d. per lb. Crimson, 3s. 4½d. to 4s. 5½d. per lb.

Arsenic.—Per ton, £45 5s. nominal, ex store.

Barium Carbonate.—Precip., d/d : 4-ton lots, £39 per ton ; 2-ton lots, £39 10s. per ton, bag packing.

Barium Chloride.—£42 15s. per ton in 2-ton lots.

Barium Sulphate (Dry Blanc Fixe).—Precip., 4-ton lots, £42 10s. per ton d/d ; 2-ton lots, £43 per ton d/d.

Bleaching Powder.—£21 per ton in casks (1 ton lots).

Borax.—Per ton for ton lots, in free 140-lb. bags, carriage paid : Anhydrous, £58 10s.; in 1-cwt. bags ; commercial, granular, £38 10s. ; crystal, £41 ; powder, £42 ; extra fine powder, £43 ; B.P., granular, £47 10s. ; crystal, £50 ; powder, £51 ; extra fine powder, £52.

Boric Acid.—Per ton for ton lots in free 1-cwt. bags, carriage paid : Commercial, granular, £67 ; crystal, £75 ; powder, £72 10s. ; extra fine powder, £74 10s. ; B.P., granular, £80 ; crystal, £84 10s. ; powder, £87 ; extra fine powder, £86 10s.

Calcium Chloride.—70/72% solid £12 10s. per ton.

Chlorine, Liquid.—£32 per ton d/d in 16/17-cwt. drums (3-drum lots).

Chromic Acid.—2s. 0⅝d. per lb., less 2½%, d/d U.K., in 1-ton lots.

Chromium Sulphate, Basic.—Crystals, £65 6s. 8d. per ton d/d U.K., in lots of 1 ton and over.

Citric Acid.—1-cwt. lots, 205s. cwt. ; 5-cwt. lots, 200s. cwt.

Cobalt Oxide.—Black, delivered, 13s. per lb.

Copper Carbonate.—MANCHESTER : 2s. 1d. per lb.

Copper Sulphate.—£77 per ton f.o.b., less 2% in 2-cwt. bags.

Cream of Tartar.—100%, per cwt., about £9 12s.

Formaldehyde.—£37 5s. per ton in casks, d/d.

Formic Acid.—85%, £86 10s. in 4-ton lots, carriage paid.

Glycerine.—Chemically pure, double distilled 1.260 S.G., £14 7s. 6d. per cwt. Refined pale straw industrial, 5s. per cwt. less than chemically pure.

Hydrochloric Acid.—Spot, about 12s. per carboy d/d, according to purity, strength and locality.

Hydrofluoric Acid.—59/60%, about 1s. to 1s. 2d. per lb.

Hydrogen Peroxide.—27.5% wt. £124 10s. per ton. 35% wt. £153 per ton d/d. Carboys extra and returnable.

Iodine.—Resublimed B.P., 15s. 4d. per lb. in 28 lb. lots.

Iodoform.—24s. 4d. per lb. in 28 lb. lots.

Lactic Acid.—Pale tech., 44 per cent by weight £122 per ton ; dark tech., 44 per cent by weight £73 per ton ex works 1-ton lots ; dark chemical quality 44 per cent by weight £109 per ton, ex works ; usual container terms.

Lead Acetate.—White : About £137 15s. per ton.

Lead Nitrate.—About £112 per ton.

Lead, Red.—Basis prices per ton. Genuine dry red lead, £124 5s. ; orange lead, £136 5s. Ground in oil : red, £142 15s. ; orange, £154 15s.

Lead, White.—Basis prices : Dry English in 5-cwt. casks, £130 10s. per ton. Ground in oil : English, 1 cwt. lots, 170s. per cwt.

Lime Acetate.—Brown, ton lots, d/d, £40 per ton ; grey, 80-82%, ton lots, d/d, £45 per ton.

Litharge.—£126 5s. per ton, in 5-ton lots.

Magnesite.—Calcined, in bags, ex works, £22 to £24.

Magnesium Carbonate.—Light, commercial, d/d, 2-ton lots, £84 10s. per ton, under 2 tons, £92 per ton.

Magnesium Chloride.—Solid (ex wharf), £14 10s. per ton.

Magnesium Oxide.—Light, commercial, d/d, under 1-ton lots, £245 per ton.

Magnesium Sulphate.—£15 to £16 per ton.

Mercuric Chloride.—Technical Powder, 23s. 9d. per lb. in 5-cwt. lots ; smaller quantities dearer.

Mercury Sulphide, Red.—27s. 3d. per lb., for 5-cwt. lots.

Nickel Sulphate.—D/d, buyers U.K. £154 per ton. Nominal.

Nitric Acid.—£35 to £40 per ton, ex-works.

Oxalic Acid.—Home manufacture, minimum 4-ton lots, in 5-cwt. casks, £129 10s. per ton, carriage paid.

Phosphoric Acid.—Technical (S.G. 1.700) ton lots, carriage paid, £92 per ton ; B.P. (S.G. 1.750), ton lots, carriage paid, 1s. 3½d. per lb.

Potash, Caustic.—Solid, £94 10s. per ton for 1-ton lots ; Liquid, £34 5s.

Potassium Carbonate. — Calcined, 96/98%, about £59 10s. per ton for 1-ton lots, ex-store.

Potassium Chloride.—Industrial, 96%, t-ton lots, £23 to £25 per ton.

Potassium Dichromate.—Crystals and granular, 11¾d. per lb., in 1-ton lots, d/d UK.

Potassium Iodide.—B.P., 13s. 1d. per lb. in 28-lb. lots ; 12s. 7d. in cwt. lots.

Potassium Nitrate.—Small granular crystals, 81s. per cwt. ex store, according to quantity.

Potassium Permanganate.—B.P., 1s. 9½d. per lb. for 1-cwt. lots ; for 3 cwt. and upwards, 1s. 8½d. per lb. ; technical, £8 7s. per cwt. ; for 5-cwt. lots.

Salammoniac.—Dog-tooth crystals, £70 per ton ; medium, £67 10s. per ton ; fine white crystals, £21 10s. to £22 10s. per ton, in casks.

Salicylic Acid. — MANCHESTER : Technical 2s. 7d. per lb. d/d.

Soda Ash.—58% ex-depot or d/d, London station, about £15 5s. 6d. per ton, 1-ton lots.

Soda, Caustic.—Solid 76/77% ; spot, £26 to £28 per ton d/d. (4 ton lots).

Sodium Acetate.—About £80 per ton d/d.

Sodium Bicarbonate.—Refined, spot, £13 10s. to £15 10s. per ton, in bags.

Sodium Bisulphite.—Powder, 60/62%, £40 per ton d/d in 2-ton lots for home trade.

Sodium Carbonate Monohydrate.—£25 per ton d/d in minimum ton lots in 2-cwt. free bags.

Sodium Chlorate.—£76 to £98 per ton, according to quantity.

Sodium Cyanide.—100% basis, 9¾d. to 10¾d. per lb.

Sodium Dichromate.—Crystals, cake and powder, 10d. lb. Net d/d UK, minimum 1-ton lots ; anhydrous, 11½d. lb. Net del. d/d UK, minimum 1-ton lots.

Sodium Fluoride.—D/d, £4 10s. per cwt.

Sodium Hyposulphite.—Pea crystals £28 a ton ; commercial, 1-ton lots, £26 per ton carriage paid.

Sodium Iodide.—B.P., 15s. 1d. per lb. in 28-lb. lots.

Sodium Metaphosphate (Calgon).—Flaked, loose in metal drums, £127 per ton.

Sodium Metasilicate.—£22 15s. per ton, d/d U.K. in ton lots.

Sodium Nitrate.—Chilean Industrial, over 98% 6-ton lots, d/d station, £27 10s.

Sodium Nitrite.—£32 per ton (4-ton lots).

Sodium Percarbonate.—12½% available oxygen, £8 2s. 10½d. per cwt. in 1-cwt. drums.

Sodium Phosphate.—Per ton d/d for ton lots : Di-sodium, crystalline, £37 10s., anhydrous, £81 ; tri-sodium, crystalline, £39 10s., anhydrous, £79.

Sodium Prussiate.—1s. to 1s. 1d. per lb. ex store.

Sodium Silicate.—£6 to £11 per ton.

Sodium Sulphate (Glauber's Salt).—About £8 10s. per ton d/d.

Sodium Sulphate (Salt Cake).—Unground. £6 per ton d/d station in bulk. MANCHESTER : £6 10s. per ton d/d station.

Sodium Sulphide.—Solid, 60/62%, spot, £32 2s. 6d. per ton, d/d, in drums ; broken, £33 2s. 6d. per ton, d/d, in drums.

Sodium Sulphite.—Anhydrous, £59 per ton ; pea crystals, £37 12s. 6d. per ton d/d station in kegs ; commercial, £23 7s. 6d. per ton d/d station in bags.

Sulphur.—Per ton for 4 tons or more, ground, £23 11s. to £26, according to fineness.

Tartaric Acid.—Per cwt. : 10 cwt. or more, £11.

Titanium Oxide.—Standard grade comm., with rutile structure, £155 per ton ; standard grade comm., £135 per ton.

Zinc Oxide.—Maximum price per ton for 2-ton lots, d/d : white seal, £95 10s. ; green seal, £94 10s. ; red seal, £93.

Solvents and Plasticisers

Acetone.—Small lots : 5-gal. drums, £129 per ton ; 10-gal. drums, £119 per ton. In 40,45-gal drums less than 1 ton, £94 per ton ; 1 to 9 tons, £91 per ton ; 10 to 49 tons, £89 per ton ; 50 tons and over, £88 per ton. All per ton d/d.

Butyl Acetate BSS.—£173 per ton, in 1-ton lots ; £171 per ton, in 10-ton lots.

***n*-Butyl alcohol, BSS.**—10 tons, in drums, £161 10s. per ton d/d.

***sec.*-Butyl Alcohol.**—5 gal. drums £159 ; 40 gal. drums : less than 1 ton £124 per ton ; 1 to 10 tons £123 per ton ; 10 tons and over £122 per ton ; 100 tons and over £120 per ton.

***tert.*-Butyl Alcohol.**—5 gal. drums £195 10s. per ton ; 40/45 gal. drums : less than 1 ton £175 10s. per ton ; 1 to 5 tons £174 10s. per ton ; 5 to 10 tons, £173 10s. ; 10 tons and over £172 10s.

Diacetone Alcohol.—Small lots : 5 gal. drums, £177 per ton ; 10 gal. drums, £167 per ton. In 40/45 gal. drums ; less than 1 ton, £142 per ton ; 1 to 9 tons, £141 per ton ; 10 to 50 tons, £140 per ton ; 50 to 100 tons, £139 per ton ; 100 tons and over, £138 per ton.

Dibutyl Phthalate.—In drums, 10 tons, 2s. per lb. d/d ; 45 gal. drums, 2s. ¾d. per lb. d/d

Diethyl Phthalate.—In drums, 10 tons, 1s. 10½d. per lb. d/d ; 45 gal. drums, 1s. 11¾d. per lb. d/d.

Dimethyl Phthalate.—In drums, 10 tons, 1s. 7½d. per lb. d/d ; 45 gal. drums, 1s. 8¾d. per lb. d/d.

Dioctyl Phthalate.—In drums, 10 tons, 2s. 8d. per lb. d/d ; 45 gal. drums, 2s. 9½d. per lb. d/d.

Ether BSS.—In 1 ton lots, 1s. 11d. per lb ; drums extra.

Ethyl Acetate.—10 tons lots, d/d, £135 per ton.

Ethyl Alcohol (PBS 66 o.p.).—Over 300,000 p. gal., 2s. 9d. ; 2,500-10,000 p. gal., 2s. 11½d. per p. gal., d/d in tankers. D/d in 40/45-gal. drums, 1d. p.p.g. extra. Absolute alcohol (75.2 o.p.) 5d. p.p.g. extra.

Methanol.—Pure synthetic, d/d, £28 to £38 per ton.

Methylated Spirit.—Industrial 66° o.p. : 500 gal. and over in tankers, 4s. 10d. per gal. d/d ; 100-499 gal. in drums, 5s. 2½d. per gal. d/d. Pyridinised 64 o.p. : 500 gal. and over in tankers, 5s. 0d. per gal. d/d ; 100-499 gal. in drums, 5s. 4½d. per gal. d/d.

Methyl Ethyl Ketone.—10-ton lots, £141 per ton d/d

Methyl *iso*Butyl Ketone.—10 tons and over £162 per ton.

***iso*Propyl Acetate.**—In drums, 10 tons, £130 per ton d/d ; 45 gal. drums, £135 per ton d/d.

***iso*Propyl Alcohol.**—Small lots : 5 gal. drums, £118 per ton ; 10-gal. drums, £108 per ton ; in 40-45 gal. drums ; less than 1 ton, £83 per ton ; 1 to 9 tons £81 per ton ; 10 to 50 tons, £80 10s. per ton 50 tons and over, £80 per ton.

Rubber Chemicals

Antimony Sulphide.—Golden, 2s. 3½d. to 3s. 1½d. per lb. Crimson, 3s. 4½d. to 4s. 5½d. per lb.

Carbon Bisulphide.—£61 to £67 per ton, according to quality.

Carbon Black.—6d. to 8d. per lb., according to packing.

Carbon Tetrachloride.—Ton lots, £76 10s. per ton.

India-rubber Substitutes.—White, 1s. 6½d. to 1s. 10½d. per lb. ; dark, 1s. 4½d. to 1s. 8d. per lb.

Lithopone.—30%, £50 per ton.

Mineral Black.—£7 10s. to £10 per ton.

Sulphur Chloride.—British, £55 per ton.

Vegetable Lamp Black.—£64 8s. per ton in 2-ton lots.

Vermilion.—Pale or deep, 15s. 6d. per lb. for 7-lb. lots.

Nitrogen Fertilisers

Ammonium Sulphate.—Per ton in 6-ton lots, d/d farmer's nearest station, March-June, £17 1s. 6d.

Compound Fertilisers.—Per ton in 6 ton lots, d/d farmer's nearest station, I.C.I. Special No. 1 £27 9s.

'Nitro-Chalk.'—£15 14s. per ton in 6-ton lots, d/d farmer's nearest station.

Sodium Nitrate.—Chilean agricultural for 6-ton lots, d/d nearest station, March to June, £26 12s. 6d. per ton.

Coal-Tar Products

Benzole.—Per gal., minimum of 200 gals. delivered in bulk, 90's, 4s. 10½d. ; pure, 5s. 2d.

Carbolic Acid.—Crystals, 1s. 4d. to 1s. 6½d. per lb. Crude, 60's, 8s. MANCHESTER : Crystals, 1s. 4½d. to 1s. 6½d. per lb., d/d crude, 8s. naked, at works.

Creosote.—Home trade, 1s. to 1s. 4d. per gal., according to quality, f.o.r. maker's works. MANCHESTER : 1s. to 1s. 8d. per gal.

Cresylic Acid.—Pale 99/99½%, 5s. 8d. per gal. ; 99.5/100%, 5s. 10d. American, duty free, for export, 5s. to 5s. 8d. naked at works.

Naphtha.—Solvent, 90/160°, 4s. 10d. per gal. for 1000-gal. lots ; heavy, 90/190°, 3s. 9½d. per gal. for 1000-gal. lots, d/d. Drums extra ; higher prices for smaller lots.

Naphthalene.—Crude, 4-ton lots, in sellers bags, £15 1s. 9d. to £22 per ton, according to m.p. ; hot pressed, £34 per ton in bulk ex-works ; purified crystals, £53 per ton d/d.

Pitch.—Medium, soft, home trade, 180s. per ton f.o.r. suppliers' works ; export trade 230s. per ton f.o.b. suppliers port.

Pyridine.—90/160°, 35s. per gal.

Toluol.—Pure, 5s. 7d. ; 90's, 4s. 10d. per gal., d/d. MANCHESTER : Pure, 5s. 8d. per gal. naked.

Xylol.—For 1000-gal. lots, 5s. 8d. to 5s. 10d. per gal., according to grade, d/d.

Intermediates and Dyes
(Prices Nominal)

***m*-Cresol** 98/100%.—3s. 9d. per lb. d/d.

***o*-Cresol** 30/31° C.—1s. 4d. per lb. d/d.

***p*-Cresol** 34/35° C.—3s. 9d. per lb. d/d.

Dichloraniline.—2s. 8½d. per lb.

Dinitrobenzene.—88/89°C., 1s. 11d. per lb.

Dinitrotoluene.—S.P. 15° C., 1s. 11½d. per lb. ; S.P. 26° C., 1s. 3d. per lb. S.P. 33°C., 1s. 1½d. per lb. ; S.P. 66/68°C., 1s. 9d. per lb.

***p*-Nitraniline.**—4s. 5½d. per lb.

Nitrobenzene.—Spot, 9½d. per lb. in 90-gal. drums, drums extra, 1-ton lots d/d buyers' works.

Nitronaphthalene.—2s. per lb.

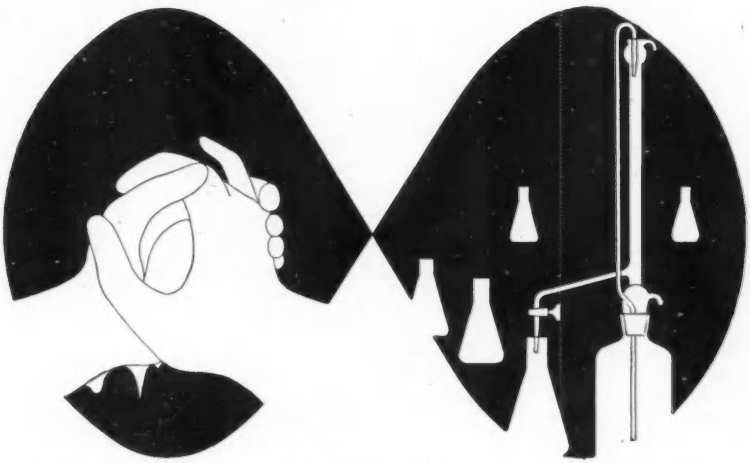
***o*-Toluidine.**—1s. 9d. per lb., in 8/10-cwt. drums, drums extra.

***p*-Toluidine.**—5s. 6d. per lb., in casks.

Dimethylaniline.—3s. 1d. per lb., packed in drums, carriage paid.

The common test of tincture of soap

" Dr. Clark then exhibited his method of ascertaining quantitatively the comparative hardness of water by means of the common test of tincture of soap, illustrated by experimental evidence, to prove the accuracy of which it is susceptible and the facility of its application."



Dr. Clark gave his demonstration at one of the first meetings of the newly formed Chemical Society in 1841, and the above is an abstract from Volume I of the Proceedings.

The B.D.H. catalogue still includes Clark's Soap Solution and testifies to the remarkable permanence of his technique. Greater accuracy and convenience in total hardness determination, however, are now obtained from the B.D.H. Hardness Solutions and Indicator based on the use of ethylenediamine-tetracetic acid as advocated by Schwarzenbach and others.

LABORATORY B·D·H CHEMICALS

THE BRITISH DRUG HOUSES LTD. B.D.H. LABORATORY CHEMICALS GROUP POOLE DORSET
LC/P/6

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Chemical & Allied Stocks & Shares

SHARES of chemical and kindred companies have been active and generally moved higher, helped by the prevailing trend in stock markets and by the good impression created by financial results that have come to hand. Imperial Chemical were particularly prominent in response to the speech of Dr. Alexander Fleck at the annual meeting and his references to the current trend of business. At one time this week the shares touched the new high record of 69s., but have eased to 68s. 3d. at the time of writing. A month ago they were 63s. Sentiment has been helped by the hope that next year the dividend on the doubled capital following the 100 per cent share bonus may be 9 per cent. Under the influence of the full results and chairman's review, Laporte 5s. shares have risen further from 17s. 6d. to 18s. 6d., while Fisons were strong following the higher interim dividend, having risen to 53s., which compares with 48s. 6d. a month ago. There was a great deal of activity in William Blythe accompanied by deal rumours, which, however, are entirely unconfirmed; these 3s. shares have risen to 17s. 9d., compared with 15s. 9d. a month ago. There was also strength and activity in British Glues 4s. shares, which rose on balance from 15s. 3d. to 16s. British Chrome Chemicals 5s. shares were good at 19s., compared with 17s. 9d. a month ago. Hickson & Welch 10s. shares strengthened to 13s. 9d., while in response to the results and higher dividend, Yorkshire Dyeware & Chemical 5s. shares advanced to 11s. 9d., a rise of 2s. 3d. on the month.

Greeff Chemicals 5s. shares were 11s. 'ex' the share bonus. Brotherton 10s. shares have risen further from 26s. to 27s. 6d., but after their rise there was a little profit-taking in Albright & Wilson 5s. shares, which came back from 25s. 9d. to 24s. 9d. Coalite & Chemical 2s. shares were up to 2s. 9d. following the results and increased dividend. There was business around 10s. in Reichhold Chemicals 5s. shares.

Shares of plastics companies have also been more active with British Xylonite at 40s., Bakelite 10s. shares 26s. 3d. and British Industrial Plastics 2s. shares 6s. against 6s. 6d. a month ago. Elsewhere, the 4s. units of the Distillers Co. remained active, awaiting the results, but at 20s. 7½d. moved a few pence lower than a month ago. United Molasses 10s. shares at 32s. 9d. recovered from an earlier reaction, and after fluctuating Unilever rallied and at 77s. were 6d. higher than a month ago. Borax Consolidated have risen further from 51s. 6d. to 52s. 6d. Boots Drug 5s. units moved up further from 24s. 7½d. to 25s. 4½d. Glaxo Laboratories 10s. shares rose from 50s. to 51s. 9d., British Drug 5s. shares were 9s. 3d. and Sangers 5s. shares 17s. 3d. United Glass Bottle were 67s. 3d. Triplex Glass have risen from 26s. 3d. to 27s. 6d. on market hopes of a higher dividend. Activity and strength of Powell Duffryn shares up to 34s. 9d. reflected the company's announcement of negotiations which may affect its holding in the Vacuum Oil Company. Oil shares generally remained active with Shell up to 120s. 7½d. Anglo-Iranian were up to the new high level of £12⅞.

Next Week's Events

SATURDAY 26 JUNE

Royal Institute of Chemistry

Harwell: AERE, 11 a.m. to 4 p.m. Visit by London section.

TUESDAY 29 JUNE

Royal Institute of Chemistry

Harrow: Kodak Ltd., 2 p.m. to 5 p.m. Visit by London section to the company's research laboratories and some production departments.

WEDNESDAY 30 JUNE

Institute of Metals

London: 4 Grosvenor Gardens, S.W.1, 5 p.m. Lecture on 'The Brittle Fracture of Metals: Some New Developments,' by Professor E. Orowan, of the Department of Mechanical Engineering, Massachusetts Institute of Technology.

THURSDAY 1 JULY

Royal Institute of Chemistry

King's Langley: A. Wander Ltd., 2.30 p.m. Visit by London section to Ovaltine factory and farms. Coach will leave 30 Russell Square, 1 p.m.

SATURDAY 3 JULY

Royal Institute of Chemistry

National Coal Board, Betteshanger Colliery, nr. Deal, Kent: 10.30 a.m. Visit by London section.

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Company News

Fisons Ltd.

An interim dividend of 5 per cent, less tax (against 4 per cent) has been declared by Fisons Ltd. The directors also announce that it is expected that it will be possible to recommend an increase in the final dividend in respect of the year ending 30 June, 1954. Last year the final dividend was 8½ per cent, less tax.

Shell Transport & Trading & Royal Dutch

Half-yearly profit statements are to be published by Shell Transport and Trading Co. Ltd. and the Royal Dutch Petroleum Co. Ltd., beginning this year, it was announced at the annual meetings of the two companies on 16 June. In addition, the Royal Dutch Petroleum meeting in Amsterdam were told that the issue of quarterly statements was contemplated. The Shell meeting approved the capitalisation of £10,902,939 of reserves and the issue of 10,902,939 ordinary shares on a one-for-five basis.

Stevenson & Howell Ltd.

The accounts of Stevenson & Howell Ltd. for 1953 show a consolidated net profit of £87,870 (against £47,352 in the previous year), before tax. The final dividend is 15 per cent (against 13 per cent), making 24 per cent for the year (against 22 per cent).

Williamson Manufacturing Ltd.

The directors of Williamson Manufacturing Ltd., scientific instrument makers, have declared a final dividend of 12½ per cent, plus a bonus of 12½ per cent, making 31¼ per cent for the year to 31 March, 1954. Each figure is the same as that for the previous year. Net profit is £32,948 (against £22,570), after tax of £60,200 (against £49,422).

Changes of Name

The following changes of name have been announced:—FEDERA PRODUCTS LTD., to ALDIMEX (ALDWYCH IMPORTING & EXPORTING) CO. LTD., on 11 May; S. & D. LTD., to BAPTONE LTD., on 20 May; F. J. HICKS LTD., to EDYVEAN & HICKS LTD., on 24 May.

Company Meeting

Imperial Chemical Industries

Dr. Alexander Fleck on Proposed Profit Sharing Scheme

THE twenty-seventh annual general meeting of Imperial Chemical Industries Ltd. was held on 17 June in London.

Dr. Alexander Fleck, the chairman, presided and, in the course of his speech, said:

The sales in 1953 were the highest in our history, and with new plants coming into operation we can confidently look forward to further increases in the years to come.

The Board's intentions, announced two years ago, of bringing the Ordinary share capital more into line with the true capital employed in the business by the capitalisation of reserves, can now be carried out.

Pharmaceutical Industry

In the Annual Report reference is made to the attitude of the Ministry of Health towards the cost of pharmaceuticals required by the National Health Service. Any effort by a Government Department to cut down waste and extravagance is commendable. In this instance, however, there is the serious danger that a rather unintelligent application of quite inappropriate costing methods may damage or even destroy the most vital parts of the pharmaceuticals industry in this country. The danger is that pharmaceutical research may be rendered so unattractive in this country and so unprofitable that this important field of research may be abandoned by one company after another, and this country may be forced to rely upon the scientific achievements of other countries. Costing principles permitting a very limited percentage of profit on the manufacturing cost of a commodity may no doubt be appropriate and proper in some cases, but I suggest that in the case of drugs which it is decided to produce and which the National Health Service wants, the rigid and unimaginative application of such principles will lead to results that are unfair to the industry.

Nationalisation

The Board remain as firmly as ever opposed to every form of nationalisation of the Company. They keep this subject of the danger of nationalisation under constant consideration and will continue to do so even though the danger may from time to time appear to recede.

Profit Sharing Scheme

The references in the Report and in the Press to the proposed Profit Sharing Scheme for employees will not have escaped your notice.

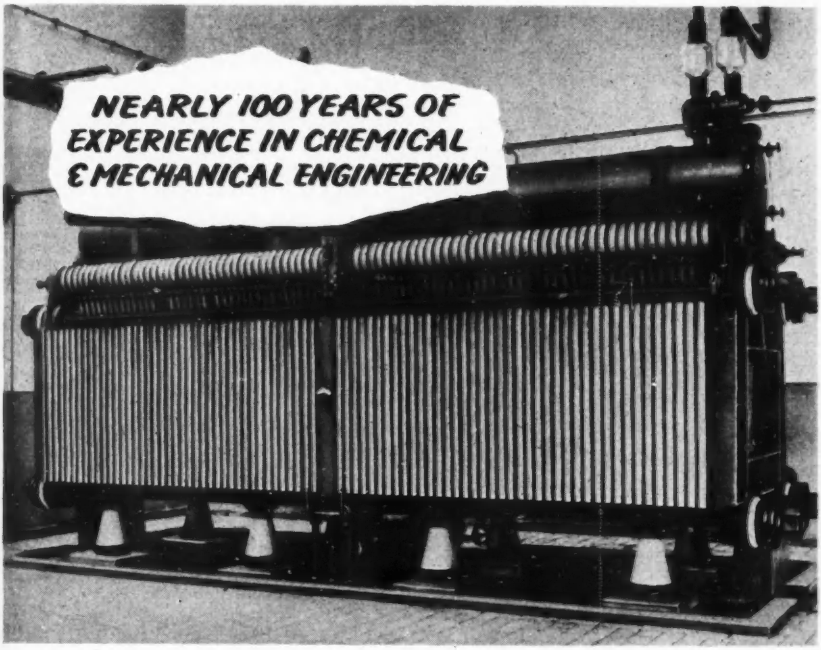
The scheme provides for an increase in the bonus if dividends are increased. Stockholders and employees will thus both share in any increased prosperity which it may be our good fortune to enjoy in future years. They will also have some share in any adversity which we may suffer.

Bonuses under the scheme are in no way part of the terms and conditions of employment and are not intended to be a substitute for fair wages and conditions.

The Outlook

So far this year the Company has enjoyed, in common with other industries in this country a period of expansion, and the prospects are in general good. In overseas markets competition is strong, but we believe that we can hold our own and in some directions gain further ground. Neither at home nor overseas can there be any easing-up, but with competent, loyal and energetic personnel throughout the whole organisation, we have every reason to believe that difficulties will be overcome and further progress made both this year and in years to come, when much of the present capital expenditure will be completed and will give us additional productive capacity.

The report and accounts were adopted.



35 YEARS OF PIONEERING DEVELOPMENT AND MANUFACTURE ON THE LINES OF

Electrolytic Plants for the production of hydrogen and oxygen from water, with the highest precision due to manufacture in our own specialised workshops.

Well proved modern Fatty Oil Plants for Sovent Extraction
Fully Continuous and Batch Refining Plants
Hydrogenation Plants
Fat Splitting and Fatty Acid Distillation Plants
Fractionating Distillation Plants
Polymerisation and Dehydration Plants

Weak and strong Nitric Acid Plants (direct or indirect method)
Denitration and Concentration Plants
Nitrogenous Fertiliser Plants

Our products will include large supplies of British manufacture.

This company has no connection whatsoever with any other company in this country of a similar name.

PINTSCH BAMAG AKTIENGESELLSCHAFT

Head Offices : COLOGNE . BERLIN . BUTZBACH (HESSEN).

Represented in Great Britain by

B. BREGMAN, DIPL.-ING., *and* PINTSCH BAMAG LIMITED
25, VICTORIA STREET, LONDON, S.W.1. *Telephone :* ABBey 6050

OUR OFFICES AND OUR LONDON REPRESENTATIVE WILL GLADLY GIVE YOU ANY ADVICE YOU MAY REQUIRE

CLASSIFIED ADVERTISEMENTS

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 *inclusive, or a woman aged* 18-59 *inclusive, unless he or she, or the employment, is excepted from the provisions of the Notifications of Vacancies Order,* 1952.

APPLICATIONS are invited from **CHEMISTS** for a progressive position in a large industrial research laboratory in the South of England, to study problems connected with the testing and use of detergents. Applicants should have a good degree or equivalent experience in the detergent and textile fields. The initial salary will be commensurate with qualifications and experience. The Company operates a pension scheme. Please reply to **BOX No. C.A. 3333, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

CHEMICAL ENGINEER wanted by expanding company of contracting chemical engineers. Excellent prospects. Age 24/27. Pension scheme. Canteen facilities. Applications, in confidence, stating age, qualifications, experience and salary required to the **SECRETARY, NORDAC, LTD., UXBRIDGE, MIDDLESEX.**

EXPERIMENTAL OFFICERS AND ASSISTANT EXPERIMENTAL OFFICERS in various Government Departments. The Civil Service Commissioners invite applications for pensionable posts. Applications may be accepted up to 31 December, 1954, but forms should be returned as soon as possible as an earlier closing date may be announced either for the competition as a whole or in one or more subjects. Interview Boards will sit at frequent intervals.

The posts are divided between following main groups and subjects :—(*a*) Mathematical and Physical Sciences; (*b*) Chemistry and Metallurgy; (*c*) Biological Sciences; (*d*) Engineering subjects; and (*e*) Miscellaneous (including e.g., Geology, Library and Technical Information Services).

AGE LIMITS.—For Experimental Officers, at least 26 and under 31 on 31 December, 1954; for Assistant Experimental Officers at least 18 and under 28 on 31 December, 1954. Extension for regular service in H.M. Forces.

Candidates must have at least one of a number of specified qualifications. Examples are: Higher School Certificate, General Certificate of Education, Scottish Leaving Certificate, Scottish Universities Preliminary Examination, Northern Ireland Senior Certificate (all in appropriate subjects and at appropriate levels), Higher National Certificate, University Degree. Candidates taking their examinations in 1954 may be admitted. Candidates without such qualifications may be admitted exceptionally on evidence of suitable experience. In general a higher standard of qualification will be looked for in the older candidates than in the younger ones.

SALARY (London) :—

Experimental Officer—£720-£890 (men); £625-£760 (women).

Assistant Experimental Officer—£290 (at age 18) to £645 (men); £545 (women).

Starting pay up to £520 (men), £490 (women). at 26, Somewhat lower outside London. Promotion prospects.

Further particulars and application forms from **CIVIL SERVICE COMMISSION, SCIENTIFIC BRANCH, 30, OLD BURLINGTON STREET, LONDON, W.1,** quoting No. S94-95/54.
451/140/4/54/JS.

SITUATIONS VACANT

CHEMIST, preferably under 30, minimum second class honours B.Sc. or A.R.I.C., required in Laboratories of West Middlesex Manufacturing Company for analytical and development work. Some experience in similar capacity desirable. Good conditions in well equipped laboratory. Write stating full particulars of previous experience, also salary required to **BOX NO. C.A. 3330, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

CHEMISTS. PERMOGLAZE, LTD., have vacancies for Assistant Chemists to take charge of section in Laboratory dealing with development, testing to **D.E.F.** and **C.S.** Specifications and works formulation. Must have completed Military Service and have reached final City and Guilds standard. Apply, giving details of experience, in confidence, to **PERMOGLAZE, LTD., BIRMINGHAM, 11.**

LAPORTE CHEMICALS, LTD., KINGSWAY, LUTON, BEDS, require young, active men who have completed their National Service commitments to train for shift supervisory duties. Minimum standard required is General Certificate or equivalent in Chemistry, Mathematics and English. Salary according to age, qualifications and experience. Pension scheme; social and sports club; canteen facilities. **APPLY TO WORKS MANAGER**

SENIOR SCIENTIFIC OFFICERS; SCIENTIFIC OFFICERS; PATENT EXAMINER AND PATENT OFFICER CLASSES. The Civil Service Commissioners invite applications for pensionable appointments. Applications may be accepted up to December 31, 1954, but early application is advised as an earlier closing date may eventually be announced. Interview Boards will sit at frequent intervals. The Scientific posts cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small; individual vacancies exist at present for candidates who have specialised in Palaeobotany, Foraminifera, Malacology and Lichenology. The Patent posts are in the Patent Office (Board of Trade), and Ministry of Supply.

Candidates must have obtained a University Degree with First or Second Class Honours in an appropriate scientific subject (including Engineering) or in Mathematics, or an equivalent qualification; or for Scientific posts, possess high professional attainments. Candidates for Senior Scientific Officer posts must in addition have had at least three years' post-graduate or other approved experience. Candidates for Scientific Officer and Patent posts taking their degrees in 1954 may apply before the result of their degree examination is known.

AGE LIMITS.—Senior Scientific Officers, between 26 and 31, but specially suitable candidates under 26 may be admitted. For Scientific Officers and Patent Classes, between 21 and 28 during 1954 (up to 31 for permanent members of the Experimental Officer Class).

SALARY.—(London) Senior Scientific Officers: (men), £975-£1,150; (women), £845-£1,025. Scientific Officers: (men), £470-£855; (women) £470-£750. Patent Examiner and Patent Officer Classes (men), £440-£760, (rates under review). Women's rates somewhat lower. Somewhat lower rates in the provinces.

Further particulars from the **CIVIL SERVICE COMMISSION, SCIENTIFIC BRANCH, TRINIDAD HOUSE, OLD BURLINGTON STREET, LONDON, W.1,** quoting No. S.53/54 for Senior Scientific Officers and S.52/54 S. 128/54 for the other posts.
1037/80/4/54/SD.

SITUATIONS VACANT

QUALIFIED ORGANIC CHEMISTS required, preferably with experience in petroleum technology and/or technology of fats. Salary according to age and experience. This appointment offers excellent opportunity for men to specialize in both academic and applied petroleum chemistry. Details to **DR. A. C. PEPPER, ALEXANDER DUCKHAM & CO., HAMMERSMITH, LONDON, W.6.**

TECHNICAL ASSISTANT required for chemical engineering division for work connected with dispersions of solids in liquids. An interest in fine particle technology an advantage. Salary according to age and experience. Good prospects. Part-time study facilities. Apply **PERSONNEL MANAGER, THORN ELECTRICAL INDUSTRIES, LTD., GT. CAMBRIDGE ROAD, ENFIELD MIDDX.**

FOR SALE

C. BARBER, LTD.

C.I. FILTER PRESS, 32 in. square plate and frame type by **MANLOVE ALLIOTT** with hydraulic closing gear. 40 chambers giving cake capacity of 40.3 cu. ft. New and unused.

500-gal. Over-driven M.S. **MIXING VESSEL.** M.S. pressure filter, 4 ft. 3 in. diam. by 5 ft. 3 in. overall height.

C.I. FILTER PRESS, 25½ in. square, by **MANLOVE ALLIOTT,** plate and frame type, 13 chambers, arranged for washing. Excellent condition.

CANNON STEAM JACKETED ENAMEL-LINED PANS 10 and 25 gallons. All new and unused.

DOULTON 25-gal. COPPERS with lids. **NEW** and unused

WELDED VESSELS of all types, in mild steel or stainless Fabricated to customer's specifications.

C. BARBER LTD.
SILVERDALE GARDENS
HAYES MIDDLESEX
Telephone—Hayes 2735/6

ADVERTISER OFFERS FOR IMMEDIATE SALE, the following plant in first-class condition.

1. Pneumatic Type Hot Air Drier suitable for drying filter cake or damp granular solids such as starch, chalk, etc. Evaporative capacity, 500 lb. of water per hour. Complete with steam heater for 60 lb. per sq. in. working pressure. Plant never used; frustrated exports.
2. One ditto. Evaporative capacity, 1,000 lb. per hour. No air heater included, but can be fitted for either steam or direct fires. Plant has been operated but in good second-hand condition.
3. One Steam-heated Continuous Tubular Evaporator suitable for wide range chemical and organic solutions, including galenicals. Evaporative capacity up to 350 lb. per hour. For use with steam at pressures up to 60 p.s.i. Plant has been used for a short while; condition as new.
4. One ditto.
5. One Continuous Steam-heated Evaporator, climbing film type, suitable for concentrating milk, fruit juices and similar products. Evaporative capacity, 1 ton per hour. Steam pressures up to 30 lb. p.s.i. Plant is brand new and never yet erected. Contact all stainless steel.

The above plants are for immediate disposal and no reasonable offer will be refused as space must be cleared. Write to **BOX No. C.A. 3328, THE CHEMICAL AGE, 154, FLEET STREET, LONDON, E.C.4.**

FOR SALE

MORTON, SON AND WARD, LIMITED,
Invite inquiries for

STAINLESS steel and mild steel **JACKETED** and **UNJACKETED** Vessels to requirements. In all sizes and arranged with mixing gear and agitators of varying types.

"MORWARD" "U"-shaped TROUGH MIXERS—in stainless steel or mild steel, made in sizes up to 3 tons. Scroll and paddle-type agitators, jacketed or unjacketed.

JACKETED PANS

100g., 150g. and 200g. **NEW** in mild steel for 100 lb. w.p., with or without mixing gear.

200g. stainless steel jacketed Pan and one jacketed **AUTOCLAVE** with detachable cover, 150 lb. in jacket.

HYDRO EXTRACTORS

30 in., 36 in., 42 in. and 72 in., by **BROADBENT** and **WATSON LAIDLAW.**

PUMPS

A selection of **MONO** and other **PUMPS** in stock, 2 in. to 5 in. New and second-hand.

MORTON, SON AND WARD, LIMITED,
WALK MILL,
DOBCROSS, NR. OLDHAM,
LANCS.
'Phone: Saddleworth 437.

6 BRAND NEW Jacketed **STERILIZING VESSELS**—7 ft. long by 3 ft. diam., complete with fittings.

2—18 in. **KEK PLATE MILLS,** complete with feeders, delivery bins, motors and entablature.

9—Worssam **ROTARY PRESSES.**

POWDER DRESSING OR SIFTING MACHINES.

1—Johnson **FILTER PRESS**—47 plates, 32 in. sq.

1—Johnson **FILTER PRESS**—30 plates, 25 in. sq.

Wood FILTER PRESS—69 plates, 2 ft. 8 in. sq.

24 in., 30 in. and 36 in. HYDRO EXTRACTORS.

Heavy Cake CRUSHING MILL—2-pair high, by Nicholson.

2—No. 4 **MIRACLE MILLS.**

1—**BALL MILL,** 3 ft. long by 4 ft. diam.

3—5-roll **REFINERS** by Baker Perkins.

1—No. 1A Water-cooled **CIRCULATOR MILL.**

2—Excellent Nickel-lined Jacketed **TILTING PANS.**

5—Excellent Porcelain **DISC MILLS.**

1—Very Fine **GARDNER SIFTER** and **MIXER,** trough 5 ft. 9 in. by 24 in. by 28 in. deep, with wood-built hopper, elevator, A.C. motor and starter.

2—**GARDNER 'G' size SIFTERS AND MIXERS.**

2—**GARDNER 'H' size steam jacketed MIXERS.**

6—**JOHNSON FILTER PRESSES** 30 chamber 24 in. square.

RICHARD SIZER, LIMITED, ENGINEERS, HULL.
Telephone: 31743.

ONE TORRANCE MICRO TWIN-ROLLER MILL. Cast rolls, 14 in. by 8 in. Water cooled. Fast and loose pulley-drive.

TWO DE LAVAL SEPARATORS, VEE-BELT DRIVE. Good condition.

THOMPSON & SON (MILLWALL), LIMITED, CUBA STREET, LONDON E.14. TEL. EAST 1844

FOR SALE

600

ROTARY VACUUM FILTER by International Combustion. Drum, 4 ft. 8 in. diam. by 1 ft. 4 in. face, giving surface area of approx. 17 sq. ft.; cast-iron construction with phosphor-bronze slotted surface plates. Alldays & Onions Blower of bronze construction, with stainless steel shaft. 12 in. flanged suction and delivery; 25 in. diam. Vee-rope pulley.

FOUR FILTER PRESSES, cast-iron plate and frame type, with 51 frames 2 ft. 5 in. sq. by 2 in. thick; 2 in. diam. bottom side feed, individual plate discharge. Ribbed type plates, hand screw closing through spur gear and pinion.

FILTER PRESS by S. H. Johnson, cast-iron plate and frame type, with pyramid surface plates and 36 frames forming cakes 24½ in. sq. by ¾ in. thick. 1½ in. diam. bottom side feed and enclosed discharge; 1½ in. diam. top side air discharge. Hand ratchet screw closing.

STEAM-DRIVEN HYDRO EXTRACTOR by Broadbent, fitted 72 in. diam. perforated basket, complete.

COUNTER-REVOLVING CAGE TYPE DISINTEGRATOR by Yeadon. Drive from two separate motors or from countershaft; at present moment both pulleys fitted with Vee belts. Output, approx. 20-30 tons per hour.

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